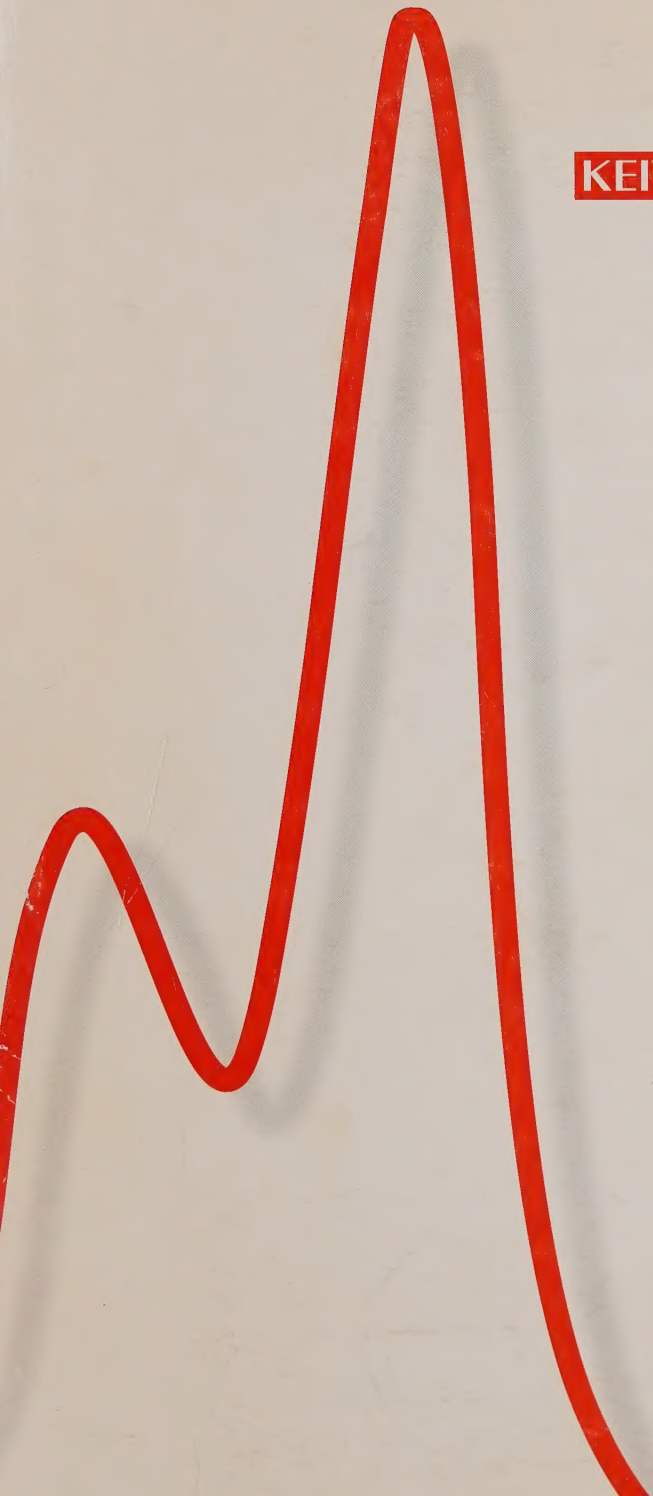

KEITHLEY METRABYTE

DAS-1700 Series

USER'S GUIDE

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DAS-1700 Series
User's Guide

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Table of Contents

Preface

1 Overview

Features 1-1
Supporting Software 1-4
Accessories 1-5

2 Setup and Installation

Unpacking the Board 2-1
Installing the Software 2-2
Configuring the Board 2-4
Creating a Configuration File 2-5
Setting the Base Address Switch 2-9
Installing the Board 2-10

3 Cabling and Wiring

Attaching Accessories 3-1
STA-1800U Screw Terminal Accessory 3-1
STP-50 Screw Terminal Panel 3-6
SSH-8 Accessory 3-7
MB01 Backplane 3-8
MB02 Expansion Backplane 3-8
EXP-1800 Expansion Accessory 3-11
Connecting Signals 3-12
Single-Ended Analog Input Signals 3-14
Differential Analog Input Signals 3-15
Avoiding a Ground Loop Problem 3-17
Analog Output Signals 3-18
Digital Signals 3-19
Synchronizing the Starting of Operations on Multiple Boards 3-20

4 Testing the Board

5 **Troubleshooting**
Identifying Symptoms and Possible Causes 5-1
Testing the Board and the Computer. 5-4
Testing the Accessory Slot and I/O Connections 5-4
Technical Support 5-5

6 **Calibrating the Board**
Equipment Requirements. 6-2
Potentiometers and Test Points 6-2
Calibration Utility 6-5

7 **Functional Description**
Block Diagrams 7-1
Analog Input Features 7-6
Channels 7-6
Input Configuration 7-6
Single-Ended Input Configuration 7-6
Differential Input Configuration 7-7
Channel Expansion 7-7
Gains and Ranges. 7-8
Channel Selection 7-9
Selecting a Single Channel 7-10
Selecting Channels Using Automatic Channel Scanning 7-10
Selecting Channels Using the Channel-Gain Queue. . 7-10
Conversion Modes 7-13
Paced Mode 7-14
Burst Mode. 7-14
Burst Mode with SSH 7-15
Clock Sources 7-15
Pacer Clock 7-15
Internal A/D Pacer Clock 7-16
External Pacer Clock. 7-16
Burst Mode Conversion Clock. 7-16

Triggers 7-17
Trigger Sources 7-17
Software Trigger 7-17
External Digital Trigger 7-18
Trigger Acquisition 7-19
Post-Trigger Acquisition 7-19
Pre-Trigger Acquisition. 7-20
About-Trigger Acquisition 7-20
Hardware Gate 7-20
Data Transfer. 7-22
Using Interrupts. 7-22
Using DMA Resources 7-22
Analog Output Features 7-23
DAS-1701ST-DA and DAS-1702ST-DA Boards 7-23
DAS-1702HR-DA Boards 7-24
DAS-1701AO and DAS-1702AO Boards 7-24
Output Ranges 7-24
Pacer Clock 7-25
Internal D/A Pacer Clock 7-25
External Pacer Clock. 7-25
Clock Used for an Analog Input Operation 7-26
Triggers 7-26
Software Trigger 7-26
External Digital Trigger 7-27
Hardware Gate 7-27
Data Transfer. 7-28
Using Interrupts. 7-28
Using DMA Resources 7-28
Using Recycle Mode 7-29
Digital I/O Features 7-29
Digital Control Signals 7-29
Strobe Signal. 7-30
Trigger/Gate Output Signal. 7-30
SSH Output Signal 7-32
Interrupts 7-33
Power 7-34

A Specifications

B Connector Pin Assignments
Main I/O Connector B-2
STA-1800U I/O Connectors J1 and J2 . . . . . B-3
STA-1800U I/O Connector J3 . . . . . B-4
STA-1800U I/O Connectors J4 to J7 and Jumper Pads J8 to J11 . . . . . B-4

C Keithley Memory Manager
Overview C-1
Installing and Setting Up the KMM in Windows 3.1 and Windows for Workgroups 3.11 . . . . . C-2
Using KMMSETUP.EXE C-3
Using a Text Editor C-3
Installing and Setting Up the KMM in Windows 95 . . . . . C-4
Removing the KMM C-5

D CE Information for the DAS-1700 Series
Limitation of Certification D-1
Declaration of Conformity D-2
Cabling Instructions for the CE Configuration D-3

Index

List of Figures

Figure 2-1. Location of the Base Address Switch 2-9
Figure 3-1. Connector Layout of an STA-1800U 3-2
Figure 3-2. Attaching an STA-1800U to a DAS-1700 Series Board 3-3
Figure 3-3. Pin Assignments for the Main I/O Connector of a DAS-1700 Series Board 3-4
Figure 3-4. Pin Assignments for Connectors J1 and J2 of the STA-1800U 3-5
Figure 3-5. Attaching an STP-50 to a DAS-1700 Series Board 3-6
Figure 3-6. Screw Terminals Assignments for the STP-50 . . . 3-6
Figure 3-7. Attaching an SSH-8 to a DAS-1700ST or DAS-1700AO Series Board 3-7
Figure 3-8. Attaching an MB01 Backplane to a DAS-1700 Series Board 3-8

Figure 3-9. Attaching MB02 Expansion Backplanes to an STA-1800U 3-9
Figure 3-10. Daisy-Chaining STA-1800Us with Attached MB02s 3-10
Figure 3-11. Daisy-Chaining EXP-1800s 3-11
Figure 3-12. Single-Ended Inputs (SIngle Channel) 3-14
Figure 3-13. Single-Ended Inputs (Multiple Channels) 3-15
Figure 3-14. Differential Inputs 3-16
Figure 3-15. Avoiding a Ground Loop Problem 3-18
Figure 3-16. Voltage Output 3-18
Figure 3-17. Synchronizing the Start of Operations on Multiple Boards 3-20
Figure 6-1. DAS-1701ST and DAS-1702ST 6-3
Figure 6-2. DAS-1702HR 6-3
Figure 6-3. DAS-1701ST-DA and DAS-1702ST-DA 6-4
Figure 6-4. DAS-1702HR-DA 6-4
Figure 6-5. DAS-1701AO and DAS-1720AO 6-5
Figure 7-1. Block Diagram of DAS-1701ST, DAS-1702ST, and DAS-1702HR Board 7-2
Figure 7-2. Block Diagram of DAS-1701ST-DA and DAS-1702ST-DA Board 7-3
Figure 7-3. Block Diagram of DAS-1702HR-DA Board 7-4
Figure 7-4. Block Diagram of DAS-1701AO and DAS-1702AO Board 7-5
Figure 7-5. Conversion Modes 7-14
Figure 7-6. Initiating Conversions with an External Digital Trigger 7-19
Figure 7-7. Hardware Gate 7-21
Figure 7-8. Timing Relationship between Data from DO0 to DO3 and Latch Strobe DOSTB 7-30
Figure 7-9. Timing for the TGOUT Signal 7-31
Figure 7-10. Timing for SSHO Signal When Not Used for SSH Hardware 7-33
Figure B-1. Main I/O Connector B-2
Figure B-2. STA-1800U I/O Connectors J1 and J2 . . . . . B-3
Figure B-3. STA-1800U I/O Connector J3 . . . . . B-4
Figure B-4. STA-1800U I/O Connectors J4 to J7 and Jumper Pads J8 to J11 . . . . . B-5
Figure D-1. ENCL-4 Enclosure with Four EXP-1800s Installed D-3
Figure D-2. Connecting the DAS-1700 Series Board to an EXP-1800, FWA-EXP, and FWA-1800U D-4

List of Tables

Table 1-1. Basic Features of DAS-1700 Series Boards 1-1
Table 2-1. Default Configuration File Settings. 2-5
Table 3-1. STA-1800U Labels for DAC Outputs 3-5
Table 5-1. Troubleshooting Information. 5-2
Table 7-1. Analog Input Ranges 7-9
Table 7-2. Maximum Throughput with Fixed Range 7-12
Table A-1. DAS-1700ST Series - Analog Input Specifications. A-2
Table A-2. DAS-1700HR Series - Analog Input Specifications. A-5
Table A-3. DAS-1700AO Series - Analog Input Specifications. A-8
Table A-4. DAS-1701ST-DA and DAS-1702ST-DA - Analog Output Specifications A-11
Table A-5. DAS-1702HR-DA - Analog Output Specifications. A-12
Table A-6. DAS-1700AO Series - Analog Output Specifications. A-12
Table A-7. DAS-1700 Series - Digital I/O Specifications. . A-14
Table A-8. DAS-1701ST, DAS-1702ST, and DAS-1702HR - Power Supply Requirements A-14
Table A-9. DAS-1701ST-DA, DAS-1702ST-DA, and DAS-1702HR-DA - Power Supply Requirements A-15
Table A-10. DAS-1700AO Series - Power Supply Requirements A-15

Preface

The *DAS-1700 Series User's Guide* provides the information needed to install and use the following boards:

Series	Boards
DAS-1700ST	DAS-1701ST, DAS-1701ST-DA, DAS-1702ST, DAS-1702ST-DA
DAS-1700HR	DAS-1702HR, DAS-1702HR-DA
DAS-1700AO	DAS-1701AO, DAS-1702AO

The manual is intended for data acquisition system designers, engineers, technicians, scientists, and other users responsible for installing, starting up, and wiring signals to DAS-1700 Series boards. It is assumed that you are familiar with data acquisition principles, with your computer, and with your particular application.

The *DAS-1700 Series User's Guide* is organized as follows:

- Chapter 1 provides an overview of the features of DAS-1700 Series boards, including a description of supported software and accessories.
- Chapter 2 describes how to unpack, install, and start up DAS-1700 Series boards.
- Chapter 3 describes how to attach accessories and how to wire signals to DAS-1700 Series boards.
- Chapter 4 describes how to use the DAS-1700 Series Control Panel to test the functions of DAS-1700 Series boards.
- Chapter 5 provides troubleshooting information.
- Chapter 6 describes how to calibrate DAS-1700 Series boards.

- Chapter 7 provides a detailed description of the features of DAS-1700 Series boards.
- Appendix A lists the specifications for DAS-1700 Series boards.
- Appendix B lists the pin assignments for the main I/O connector of DAS-1700 Series boards and for the connectors of DAS-1700 Series accessories.
- Appendix C describes how to allocate memory using the Keithley Memory Manager.
- Appendix D contains information on CE certification.

An index completes this manual.

1

Overview

This chapter contains the following sections:

- **Features** - an overview of the features of DAS-1700 Series boards.
- **Supporting Software** - a description of the software available for DAS-1700 Series boards.
- **Accessories** - a description of the hardware accessories available for DAS-1700 Series boards.

Features

The DAS-1700 Series is a family of data acquisition boards for an IBM® PC AT® (or equivalent) computer operating in the Windows® environment. The basic features of the DAS-1700 Series boards are listed in Table 1-1.

Table 1-1. Basic Features of DAS-1700 Series Boards

Series	Boards	Basic Features
DAS-1700ST	DAS-1701ST	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 5, 50, and 250 Digital I/O: four input lines, four output lines
	DAS-1701ST-DA	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 5, 50, and 250 Analog output: four 12-bit DACs, ±10 V range Digital I/O: four input lines, four output lines

Table 1-1. Basic Features of DAS-1700 Series Boards (cont.)

Series	Boards	Basic Features
DAS-1700ST (cont.)	DAS-1702ST	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 2, 4, and 8 Digital I/O: four input lines, four output lines
	DAS-1702ST-DA	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 2, 4, and 8 Analog output: four 12-bit DACs, ±10 V range Digital I/O: four input lines, four output lines
DAS-1700HR	DAS-1702HR	Analog input: 16 single-ended or eight differential channels, 16-bit resolution, 50 ksamples/s maximum throughput, gains of 1, 2, 4, and 8 Digital I/O: four input lines, four output lines
	DAS-1702HR-DA	Analog input: 16 single-ended or eight differential channels, 16-bit resolution, 50 ksamples/s maximum throughput, gains of 1, 2, 4, and 8 Analog output: two 16-bit DACs, ±10 V range Digital I/O: four input lines, four output lines
DAS-1700AO	DAS-1701AO	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 5, 50, and 250 Analog output: two 12-bit DACs, ±5 V or ±10 V range, waveform quality Digital I/O: four input lines, four output lines
	DAS-1702AO	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 2, 4, and 8 Analog output: two 12-bit DACs, ±5 V or ±10 V range, waveform quality Digital I/O: four input lines, four output lines

Additional features of DAS-1700 Series boards are as follows:

- The boards support up to 256 analog input channels using EXP-1800 or MB02 expansion accessories.
- Analog input channels are individually software-selectable for gain.
- A 256-location hardware channel-gain queue supports the sampling of analog input channels at the same or different gains, in sequential or nonsequential channel order.
- For analog input operations on DAS-1700ST Series and DAS-1700AO Series boards, burst mode emulates simultaneous-sample-and-hold (SSH) using the SSH-8 accessory.
- For analog input operations, dual-channel DMA (Direct Memory Access) allows the acquisition of more than 65,536 samples.
- For DAS-1700ST Series and DAS-1700HR Series boards, a hardware trigger/gate is supported for analog input operations; for DAS-1700AO Series boards, a hardware trigger/gate is supported for analog input and analog output operations. Pre-trigger, post-trigger, and about-trigger acquisitions are supported for analog input operations.
- All boards contain a 1024-word A/D FIFO (first-in, first-out data buffer for analog-to-digital operations) to ensure the continuous sampling of analog input data at higher conversion rates; DAS-1700AO Series boards also contain a 2048-word D/A FIFO (first-in, first-out data buffer for digital-to-analog operations) to support recycle-mode waveform generation.
- Pulsed interrupts allow multiple boards to share interrupt levels.
- All connections are made through the 50-pin main I/O (input/output) connector at the rear panel of the computer.
- The boards provide ±15 V and +5 V power for external circuitry.

For more information on these features, refer to Chapter 7.

Supporting Software

The following software is available for operating DAS-1700 Series boards:

- **ASO-1700 software package** - This package is shipped with the DAS-1700 Series board. The package includes function libraries for writing programs in the Windows 3.1, Windows for Workgroups 3.11, or Windows 95 environment using Microsoft® C/C++, Borland® C/C++, Microsoft Visual C++™, Borland Turbo Pascal® for Windows, or Microsoft Visual Basic® for Windows. The package also includes support files, utility programs, and language-specific example programs. Refer to the *DAS-1700 Series Function Call Driver User's Guide* for more information.

  The following utility programs are provided with the ASO-1700 software package:

  – *DAS-1700 Series Configuration Utility* - The configuration utility (CFG1700.EXE) runs under DOS and allows you to create or modify a configuration file. The configuration file provides information about the board; this information is used by the DAS-1700 Series Function Call Driver and other software packages to perform the board's operations. Refer to page 2-5 for more information.

  – *DAS-1700 Series Control Panel* - The control panel (CTL1700.EXE) runs under Windows and allows you to perform operations on DAS-1700 Series boards without programming. It provides a quick way to test your board and monitor your operation. Refer to Chapter 4 for more information.

  – *DAS-1700 Series Calibration Utility* - The calibration utility (CAL1700.EXE) runs under DOS and allows you to calibrate the analog input circuitry of DAS-1700 Series boards and EXP-1800 expansion accessories. Refer to Chapter 6 for more information.

- **TestPoint**™- This optional software package allows you to create data acquisition programs in the Windows 3.1, Windows for Workgroups 3.11, or Windows 95 environment using a set of professional software tools instead of programming. Refer to the Keithley MetraByte catalog or contact your local sales office for more information.

- **Driver*LINX***®- This optional, high-performance driver allows you to create custom data acquisition programs in the Windows 3.1, Windows for Workgroups 3.11, Windows 95, or Windows NT environment. Refer to the Keithley MetraByte catalog or contact your local sales office for more information.

Accessories

The following accessories are available for DAS-1700 Series boards:

- **STP-50 screw terminal panel** - Provides screw terminals that allow you to access the functions of a board; connects to the main I/O connector of a DAS-1700 Series board through a CDAS-2000 or SDAS-2000 cable.
- **STA-1800U screw terminal accessory** - Provides screw terminals that allow you to access the functions of a board and connectors that allow you to attach an MB01 backplane, MB02 expansion backplane, or SSH-8 accessory; connects to the main I/O connector of a DAS-1700 Series board through a CDAS-2000 or SDAS-2000 cable.
- **RMT-02 rack mount enclosure** - Allows you to mount the STA-1800U accessory.
- **SSH-8 accessory** - An 8-channel accessory that provides simultaneous sample-and-hold; you can use up to two SSH accessories with a DAS-1700ST Series or DAS-1700AO Series board. Refer to the *SSH-8 User's Guide* for more information.
- **MB01 backplane** - A 16-channel backplane; plug-in MB Series modules provide isolation and signal-conditioning. You can use one MB01 backplane with a DAS-1700 Series board. Refer to the *MB Series User's Guide* for more information.
- **MB02 expansion backplane** - A 16-channel expansion backplane; plug-in MB Series modules provide isolation and signal-conditioning. You can use up to 16 MB02 expansion backplanes with a DAS-1700 Series board. Refer to the *MB Series User's Guide* for more information.
- **EXP-1800 expansion accessory** - A 16-channel expansion accessory; you can use up to 16 EXP-1800 expansion accessories with a DAS-1700 Series board. Refer to the *EXP-1800 User's Guide* for more information.

- **PG-408A DC/DC converter** - Required on EXP-1800 expansion accessories that use external power.
- **C16-MB1 cable** - A cable with a 37-pin, female D-type connector and a 26-pin, female header connector; allows you to connect an STA-1800U screw terminal accessory to an MB01 backplane.
- **C-2600 cable** - An 18-inch ribbon cable with a 26-pin female header connector at each end; allows you to connect an STA-1800U screw terminal accessory to an MB02 expansion backplane.
- **CDAS-2000 and SDAS-2000 cables** - The CDAS-2000 is a 24-inch ribbon cable with a 50-pin female header connector and a 50-pin female D-type connector; it allows you to connect a DAS-1700 Series board to an STA-1800U screw terminal accessory, an STP-50 screw terminal panel, or an EXP-1800 expansion accessory. The SDAS-2000 is a shielded version of the CDAS-2000; the SDAS-2000 is recommended for use with DAS-1700HR Series boards.
- **CAB-50 Series cable** - A ribbon cable with a 50-pin header connector on each end that allows you to daisy-chain EXP-1800 expansion accessories. The CAB-50 is 4 inches long and is recommended when the EXP-1800 is mounted in an ENCL enclosure; the CAB-50/1 is 18 inches long and is recommended when the EXP-1800 is mounted on a standoff.
- **CACC-2000** - A 24-inch ribbon cable with a 50-pin female header connector on each end; allows you to daisy-chain STA-1800U screw terminal accessories when attaching MB02 expansion backplanes.
- **C-1800** - An 18-inch ribbon cable with a 37-pin, female D-type connector on each end; allows you to connect an STA-1800U screw terminal accessory to an SSH-8 accessory.

2

Setup and Installation

This chapter contains the following sections:

- **Unpacking the Board** - describes how to unpack and inspect a DAS-1700 Series board.
- **Installing the Software** - describes how to install the AS0-1700 software package.
- **Configuring a Board** - describes how to use the DAS-1700 Series Configuration Utility to specify configuration options and how to set the base address switch on a DAS-1700 Series board.
- **Installing a Board** - describes how to install a DAS-1700 Series board in the computer.

Unpacking the Board

To prevent any damage to your DAS-1700 Series board, perform the following steps when unpacking the board:

1. Remove the wrapped DAS-1700 Series board from its outer shipping carton.
2. If you are not equipped with a grounded wrist strap, discharge static electricity by holding the wrapped board in one hand while placing your other hand firmly on a metal portion of the computer chassis. (Your computer must be turned OFF but grounded.)

   Note that if you are equipped with a grounded wrist strap, static electricity is discharged as soon as you hold the wrapped board.
3. Carefully remove the board from its anti-static wrapping material. (You may wish to store the wrapping material for future use.)

4. Inspect the board for signs of damage. If any damage is apparent, arrange to return the board to the factory; refer to page 5-5 for more information.
5. Check the remaining contents of your package against the packing list to ensure that your order is complete. Report any missing items immediately.
6. Once you have determined that the board is acceptable, install the software and configure the board, using the instructions in the following sections.

Note: DAS-1700 Series boards are factory calibrated; they require no further adjustment prior to installation. If at a later time you decide to recalibrate the board, refer to Chapter 6 for instructions.

Installing the Software

To install the ASO-1700 software package, perform the following steps:

1. Make a back-up copy of the supplied disks. Use the copies as your working disks and store the originals as backup disks.
2. Insert disk #1 into an appropriate disk drive of your computer.
3. Start Windows, if necessary.
4. *If you are using Windows 3.1 or Windows for Workgroups 3.11*:
   - On the **File** menu of the Program Manager, click **Run**.

   If you are using Windows 95:
   - From the Windows 95 task bar, click **Start** and then **Run**.
5. In the Run dialog box, enter the appropriate drive letter and the setup command. For example, if the disk is in drive A, enter

   ```
   a:\setup
   ```

   and then click **OK**.

The installation program prompts you for your installation preferences, including which languages you will be using and the drive and directory you want to copy the software to. It also prompts you to insert additional disks, as necessary.

6. Continue to insert disks and respond to prompts, as appropriate.

   When the installation program prompts you for a drive designation, enter a designation of your choosing or accept the default drive C. When the installation program prompts you for a directory name, enter a name of your choosing or accept the default name.

   The installation program creates a directory on the specified drive and copies all files, expanding any compressed files.

   The installation program also creates a DAS-1700 program group; this program group includes icons for the Keithley MetraByte utilities, example programs, and help files.

7. *If you are using Windows 95 to write 32-bit programs*, install the ASO-Win95/32-Bit software, as follows:

   - Insert the ASO-Win95/32-Bit disk into the appropriate disk drive.
   - Click **Run** on the **Start** menu.
   - In the Run dialog box, enter the appropriate drive letter and the setup command. For example, if the disk is in drive A, enter

     ```
     a:\setup
     ```

     and then click **OK**.
   - Respond to the prompts, as appropriate. To avoid overwriting files with the same name, install the ASO-Win95/32-Bit software in a different directory from the one in which you installed the ASO-1700 software package.

8. When the installation program notifies you that the installation is complete, review the following files:

   - FILES.TXT lists and describes all the files copied to the hard disk by the installation program.
   - README.TXT contains information that was not available when this manual was printed. (Note that there are two README.TXT files: one in the ASO-1700 installation directory and another in the ASO-Win95/32-Bit installation directory.)

Configuring the Board

You can configure the following items for DAS-1700 Series boards:

- Board type
- Base address
- A/D DMA channel and D/A DMA channel
- Interrupt level
- Input configuration (bipolar or unipolar)
- Input range type (single-ended or differential)
- Ground reference
- Number of SSH-8 accessories used and the gains for each
- Number of EXP-1800 or MB02 expansion accessories used

You specify the base address by setting a switch on the board. Refer to page 2-9 for information on setting the base address. In addition, if you intend to use your DAS-1700 Series board with the DAS-1700 Series Function Call Driver, DAS-1700 Series Control Panel, or any program that requires a configuration file, you must indicate all the configuration options in a configuration file. Refer to page 2-5 for information on creating a configuration file; refer to Chapter 7 for more information about the configuration options.

Note: The base address setting in the configuration file must match the setting of the base address switch on the board.

Creating a Configuration File

A default configuration file (DAS1700.CFG) is provided in the AS0-1700 software package. DAS1700.CFG contains a set of default configuration options that take effect whenever you install or power-up a DAS-1700 Series board. These default configuration options are listed in Table 2-1.

Table 2-1. Default Configuration File Settings

Options	Default Settings
Board	0
Board Type	DAS1702ST
Base Address	&H300
A/D DMA Chan	5
D/A DMA Chan	N/A
IRQ Level	10
A/D Mode	Bipolar
A/D Config	Differential
A/D Comm Mode	N/A
# of SSHs	0
SSH Gains	N/A
# of EXPs	0

If the default options are appropriate for your application, you can skip the rest of this section. If the default options are not appropriate for your application, you must specify the appropriate options in a configuration file, using the CFG1700.EXE configuration utility.

To create a new configuration file or modify an existing configuration file, perform the following steps:

1. Start the configuration utility from DOS or Windows as follows:

   – *From DOS*, change to the directory containing CFG1700.EXE and enter the following at the DOS prompt:

     ```
     CFG1700 filename.cfg
     ```

     where *filename.cfg* is the name of the configuration file you wish to modify or create.

   – *If you are in Windows 3.1 or Windows 3.11 for Workgroups and want to modify the default configuration file DAS1700.CFG*, double-click the configuration utility icon in the DAS-1700 program group.

   – *If you are in Windows 95 and want to modify the default configuration file DAS1700.CFG*, point to **Programs**, **Keithley DAS-1700**, and **DAS-1700 Configuration** on the **Start** menu.

   – *If you are in Windows 3.1 or Windows 3.11 for Workgroups and want to create a new configuration file or modify an existing configuration file*, click **Run** on the **File** menu, type the following at the command line in the Run dialog box, and click **OK**:

     ```
     path CFG1700 filename.cfg
     ```

     where *path* is the complete path to CFG1700.EXE and *filename.cfg* is the name of the configuration file you wish to modify or create.

   – *If you are in Windows 95 and want to create a new configuration file or modify an existing configuration file*, click **Run** on the **Start** menu, type the following at the command line in the Run dialog box, and click **OK**:

     ```
     path CFG1700 filename.cfg
     ```

     where *path* is the complete path to CFG1700.EXE and *filename.cfg* is the name of the configuration file you wish to modify or create.

   The configuration utility displays the opening screen with the configuration file name shown.

2. Enter the number of boards you plan to configure (**1** to **3**).

   The utility displays the menu box for the first board (board 0, which is shown in the upper-left corner of the menu box), with the configuration options shown.

   If *filename.cfg* exists in the directory containing CFG1700.EXE, the utility displays the configuration options for *filename.cfg*. If *filename.cfg* is a file to be created, the utility displays the default configuration options. If you did not specify a configuration file, the utility displays the default configuration file DAS1700.CFG.

3. To change the setting for a configuration option, use the arrow keys to highlight the option, press **Enter** to display a list of settings for that option, use the arrow keys to highlight the desired setting, then press **Enter** again to select the setting. These instructions are summarized in the Commands/Status box at the bottom of the screen.

   The menu box contains the following configuration options:

   - *Board Type* - Select the type of board you are configuring.
   - *Base Address* - Select a base address from 200h to 3F0h (in increments of 10h).

     Note: After you press **Enter** to select the base address, the setting for the base address switch is shown in the menu box. Make sure that you set the base address switch on the board to match the base address setting in the configuration file. Refer to page 2-9 for information.

   - *A/D DMA Chan(nel)* - Select the DMA channel or channel pairs to use for analog input operations.
   - *D/A DMA Chan* - Select the DMA channel to use for analog output operations.

     Note: This option is applicable to DAS-1700AO Series boards only; DMA channel pairs are not supported.

   - *IRQ (interrupt) Level* - Select the interrupt level.
   - *A/D Mode* - Select a bipolar or unipolar input range type.

- *A/D Config(uration)* - Select a differential or single-ended input configuration.

  Note: If you are using an MB01 backplane, MB02 expansion backplanes, or EXP-1800 expansion accessories, you must select a single-ended input configuration.

- *A/D Com(mon) Mode* - Select a low-level common-mode ground reference (LL-GND) or a user-defined common-mode ground reference (User).

  Note: This option is available only if the input configuration is single-ended.

- *# of SSHs* - Select the number of attached SSH-8 accessories.

  Note: If you are using a DAS-1700HR Series board, make sure that you use the default setting of 0.

- *SSH Gains* - If you are using an SSH-8/SG, select the gain for each channel on each SSH-8/SG.

  Note: This option is available only if the number of SSH-8 accessories is greater than 0. If you are using an SSH-8/FG, you do not have to use this option; the fixed gain of 0.5 is assumed for each channel.

- *# of EXPs* - Select the number of attached EXP-1800 expansion accessories or MB02 expansion backplanes.

  Note: Since an MB01 backplane does not provide channel expansion, do not count an MB01 in this number.

4. If you are configuring more than one board, press **N** to see the menu box for the next board.
5. When you complete the changes for all boards, press **Esc**.

   The configuration utility asks you whether you want to save the changes.
6. Press **Y** for *yes* or **N** for *no*.

Setting the Base Address Switch

DAS-1700ST Series and DAS-1700HR Series boards require 16 consecutive 8-bit locations in the I/O space of your computer starting at the base address. DAS-1700AO Series boards require 26 8-bit locations in the I/O space of your computer: 16 consecutive locations starting at the base address and 10 locations starting at the base address plus 400h.

DAS-1700 Series boards are shipped with a base address of 300h. If any of the required address locations starting at base address 300h are being used by another resource in your system (including another DAS-1700 Series board), you must reconfigure the base address using the base address switch. The base address switch is a 6-position DIP switch located as shown in Figure 2-1.

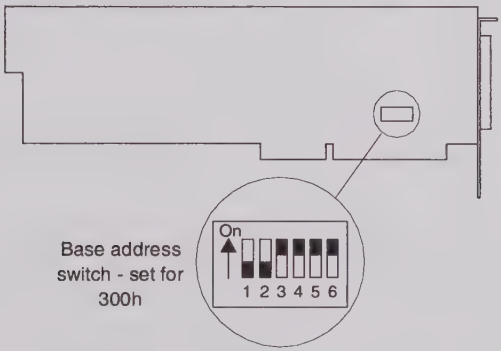


Figure 2-1. Location of the Base Address Switch

To reset this switch to another base address, use the configuration utility (described on page 2-5) to select a new base address and then view the corresponding switch settings in the menu box diagram. Make sure that the setting of the base address switch on the board matches the base address setting in the configuration file.

Caution: Make sure that power is turned OFF. Installing or removing a board while power is ON can damage your computer.

To install a DAS-1700 Series board, perform the following steps:

1. Turn power to the computer and all attached equipment OFF.
2. Remove the computer chassis cover.
3. Select an unoccupied accessory slot. DAS-1700 Series boards require a full-size slot.
4. Remove the corresponding blank plate from the I/O connector panel.
5. Make sure the setting of the base address switch matches the base address setting in the configuration utility.
6. Insert and secure the board in the selected slot.
7. Replace the computer cover.
8. Turn power to the computer ON.

After you install the DAS-1700 Series board in the computer, you can attach an accessory board and wire the appropriate signals to the board; refer to Chapter 3 for information. Before writing your program, you can test the functions of the board using the DAS-1700 Series Control Panel. Refer to Chapter 4 for more information about the control panel.

Refer to the documentation provided with your computer for more information on installing boards.

3

Cabling and Wiring

This chapter contains the following sections:

- **Attaching Accessories** - describes how to attach supported accessories to DAS-1700 Series boards.
- **Connecting Signals** - describes how to wire signals to DAS-1700 Series boards.
- **Synchronizing the Start of Operations on Multiple Boards** - describes how to synchronize the start of analog input operations on multiple DAS-1700 Series boards.

Attaching Accessories

The following sections describe how to attach accessories to DAS-1700 Series boards.

STA-1800U Screw Terminal Accessory

The STA-1800U screw terminal accessory contains the following components:

- Two 50-pin male connectors (J1 and J2). Use J1 for cabling to the main I/O connector of DAS-1700 Series boards; use J2 for cabling to a second STA-1800U.
- 53 labeled screw terminals for connections from sensor outputs and test equipment.

- Four 26-pin male connectors (J4, J5, J6, and J7) for cabling to MB02 expansion backplanes.
- One 37-pin male connector (J3) for cabling to SSH-8 accessories or to an MB01 backplane.

Figure 3-1 shows the connector layout of an STA-1800U screw terminal accessory.

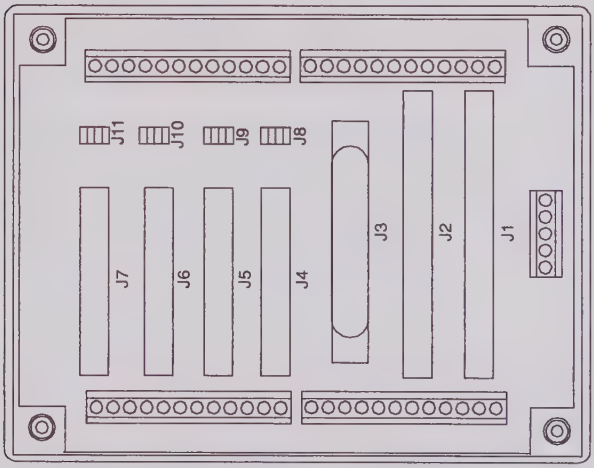


Figure 3-1. Connector Layout of an STA-1800U

To attach an STA-1800U to a DAS-1700 Series board, use a CDAS-2000 or SDAS-2000 cable. Connect one end of the cable to the main I/O connector of the DAS-1700 Series board and the other end of the cable to connector J1 of the STA-1800U, as shown in Figure 3-2.

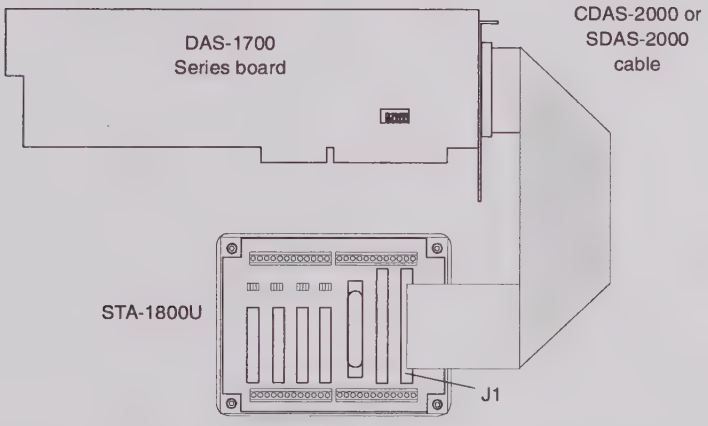


Figure 3-2. Attaching an STA-1800U to a DAS-1700 Series Board

Pin assignments for the main I/O connector of a DAS-1700 Series board are shown in Figure 3-3.

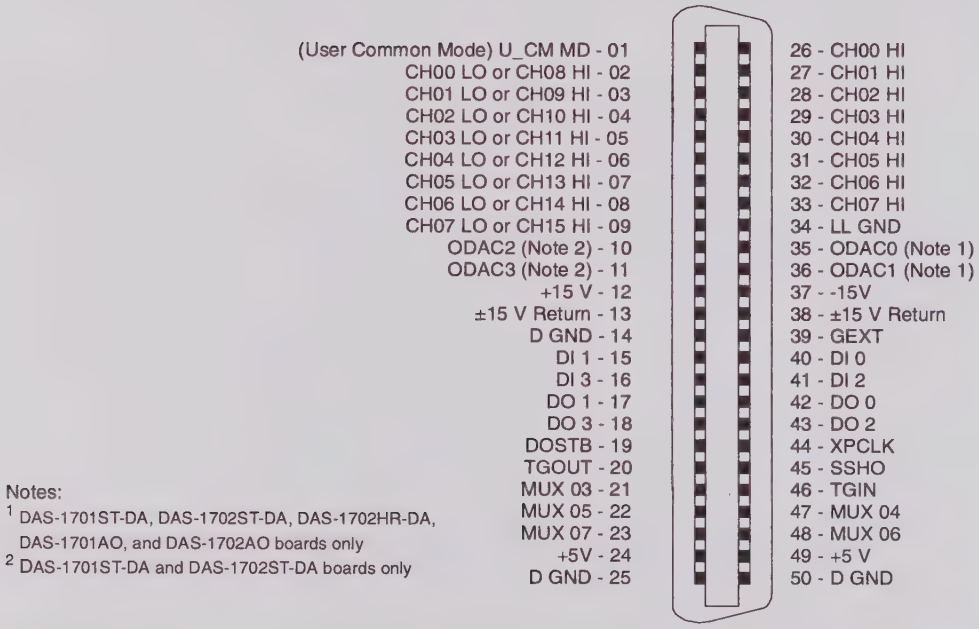

(User Common Mode) U_CM MD - 01
CH00 LO or CH08 HI - 02
CH01 LO or CH09 HI - 03
CH02 LO or CH10 HI - 04
CH03 LO or CH11 HI - 05
CH04 LO or CH12 HI - 06
CH05 LO or CH13 HI - 07
CH06 LO or CH14 HI - 08
CH07 LO or CH15 HI - 09
ODAC2 (Note 2) - 10
ODAC3 (Note 2) - 11
+15 V - 12
±15 V Return - 13
D GND - 14
DI 1 - 15
DI 3 - 16
DO 1 - 17
DO 3 - 18
DOSTB - 19
TGOUT - 20
MUX 03 - 21
MUX 05 - 22
MUX 07 - 23
+5V - 24
D GND - 25
26 - CH00 HI
27 - CH01 HI
28 - CH02 HI
29 - CH03 HI
30 - CH04 HI
31 - CH05 HI
32 - CH06 HI
33 - CH07 HI
34 - LL GND
35 - ODAC0 (Note 1)
36 - ODAC1 (Note 1)
37 - -15V
38 - ±15 V Return
39 - GEXT
40 - DI 0
41 - DI 2
42 - DO 0
43 - DO 2
44 - XPCLK
45 - SSHO
46 - TGIN
47 - MUX 04
48 - MUX 06
49 - +5 V
50 - D GND
Notes:
[1] DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR-DA, DAS-1701AO, and DAS-1702AO boards only
[2] DAS-1701ST-DA and DAS-1702ST-DA boards only

Figure 3-3. Pin Assignments for the Main I/O Connector of a DAS-1700 Series Board

Pin assignments for connectors J1 and J2 of the STA-1800U are shown in Figure 3-4.

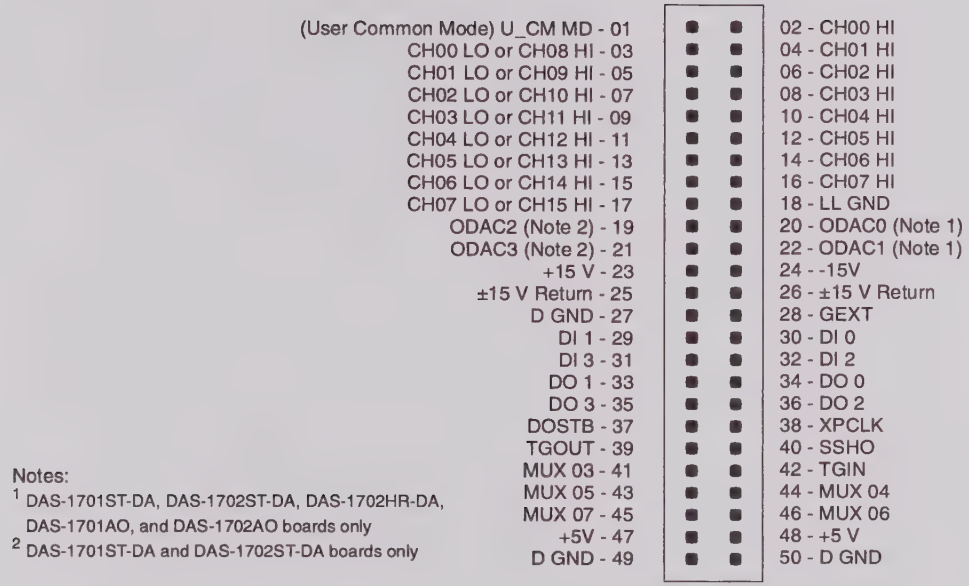

(User Common Mode) U_CM MD - 01
CH00 LO or CH08 HI - 03
CH01 LO or CH09 HI - 05
CH02 LO or CH10 HI - 07
CH03 LO or CH11 HI - 09
CH04 LO or CH12 HI - 11
CH05 LO or CH13 HI - 13
CH06 LO or CH14 HI - 15
CH07 LO or CH15 HI - 17
ODAC2 (Note 2) - 19
ODAC3 (Note 2) - 21
+15 V - 23
±15 V Return - 25
D GND - 27
DI 1 - 29
DI 3 - 31
DO 1 - 33
DO 3 - 35
DOSTB - 37
TGOUT - 39
MUX 03 - 41
MUX 05 - 43
MUX 07 - 45
+5V - 47
D GND - 49
02 - CH00 HI
04 - CH01 HI
06 - CH02 HI
08 - CH03 HI
10 - CH04 HI
12 - CH05 HI
14 - CH06 HI
16 - CH07 HI
18 - LL GND
20 - ODAC0 (Note 1)
22 - ODAC1 (Note 1)
24 - -15V
26 - ±15 V Return
28 - GEXT
30 - DI 0
32 - DI 2
34 - DO 0
36 - DO 2
38 - XPCLK
40 - SSHO
42 - TGIN
44 - MUX 04
46 - MUX 06
48 - +5 V
50 - D GND
Notes:
1 DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR-DA, DAS-1701AO, and DAS-1702AO boards only
2 DAS-1701ST-DA and DAS-1702ST-DA boards only

Figure 3-4. Pin Assignments for Connectors J1 and J2 of the STA-1800U

Note that the screw terminals for the DAC (digital-to-analog converter) outputs are labeled differently for Revisions 1 and 2 of the STA-1800U. These differences are shown in Table 3-1.

Table 3-1. STA-1800U Labels for DAC Outputs

DAC	Rev. 1 Label	Rev. 2 Label
0	DAC0 OUT	ODAC0
1	DAC1 OUT	ODAC1
2	DAC0 IN	ODAC2
3	DAC1 IN	ODAC3

STP-50 Screw Terminal Panel

To attach an STP-50 screw terminal panel to a DAS-1700 Series board, use a CDAS-2000 or SDAS-2000 cable. Connect one end of the cable to the main I/O connector of the DAS-1700 Series board and the other end of the cable to the STP-50, as shown in Figure 3-5. Screw terminals assignments for the STP-50 are shown in Figure 3-6.

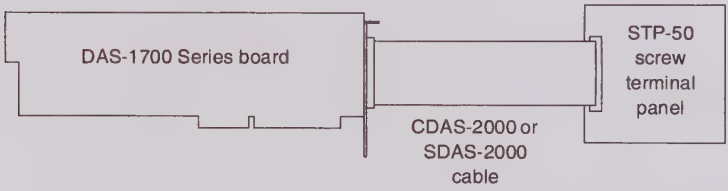
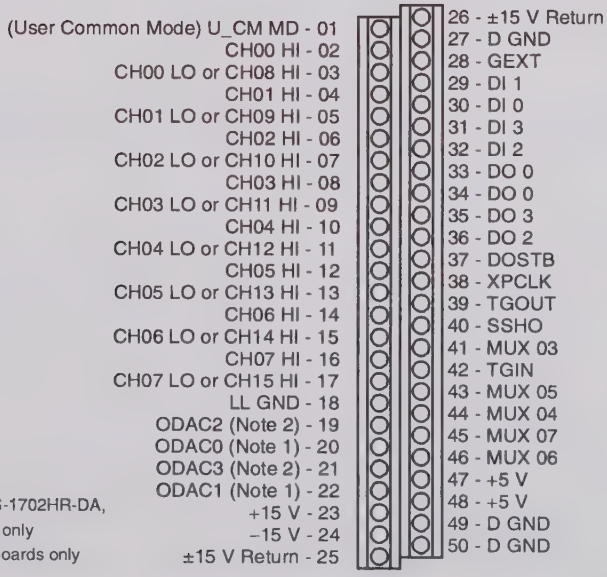


Figure 3-5. Attaching an STP-50 to a DAS-1700 Series Board


(User Common Mode) U_CM MD - 01
CH00 HI - 02
CH00 LO or CH08 HI - 03
CH01 HI - 04
CH01 LO or CH09 HI - 05
CH02 HI - 06
CH02 LO or CH10 HI - 07
CH03 HI - 08
CH03 LO or CH11 HI - 09
CH04 HI - 10
CH04 LO or CH12 HI - 11
CH05 HI - 12
CH05 LO or CH13 HI - 13
CH06 HI - 14
CH06 LO or CH14 HI - 15
CH07 HI - 16
CH07 LO or CH15 HI - 17
LL GND - 18
ODAC2 (Note 2) - 19
ODAC0 (Note 1) - 20
ODAC3 (Note 2) - 21
ODAC1 (Note 1) - 22
+15 V - 23
–15 V - 24
±15 V Return - 25
26 - ±15 V Return
27 - D GND
28 - GEXT
29 - DI 1
30 - DI 0
31 - DI 3
32 - DI 2
33 - DO 0
34 - DO 0
35 - DO 3
36 - DO 2
37 - DOSTB
38 - XPCLK
39 - TGOUT
40 - SSHO
41 - MUX 03
42 - TGIN
43 - MUX 05
44 - MUX 04
45 - MUX 07
46 - MUX 06
47 - +5 V
48 - +5 V
49 - D GND
50 - D GND

Notes:
[1] DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR-DA, DAS-1701AO, and DAS-1702AO boards only
[2] DAS-1701ST-DA and DAS-1702ST-DA boards only

Figure 3-6. Screw Terminals Assignments for the STP-50

SSH-8 Accessory

DAS-1700ST Series and DAS-1700AO Series boards can accept one or two SSH-8 accessories. (DAS-1700HR Series boards do not support SSH-8 accessories). You attach an SSH-8 to a DAS-1700ST Series or DAS-1700AO Series board through an STA-1800U screw terminal accessory. Note that attached SSH-8 accessories must be set as slaves.

To attach an SSH-8 to a STA-1800U, use a C-1800 cable, as shown in Figure 3-7. Refer to the *SSH-8 User's Guide* for more information about SSH-8 accessories.

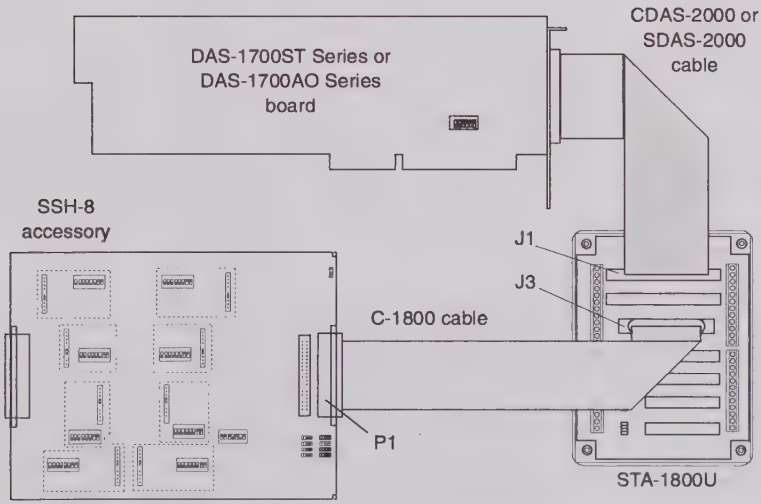


Figure 3-7. Attaching an SSH-8 to a DAS-1700ST or DAS-1700AO Series Board

MB01 Backplane

A DAS-1700 Series board configured for single-ended inputs can accept one MB01 backplane through an STA-1800U screw terminal accessory. To attach an MB01 backplane to an STA-1800U, use a C16-MB1 cable, as shown in Figure 3-8. Refer to the *MB Series User's Guide* for more information about MB01 backplanes and modules.

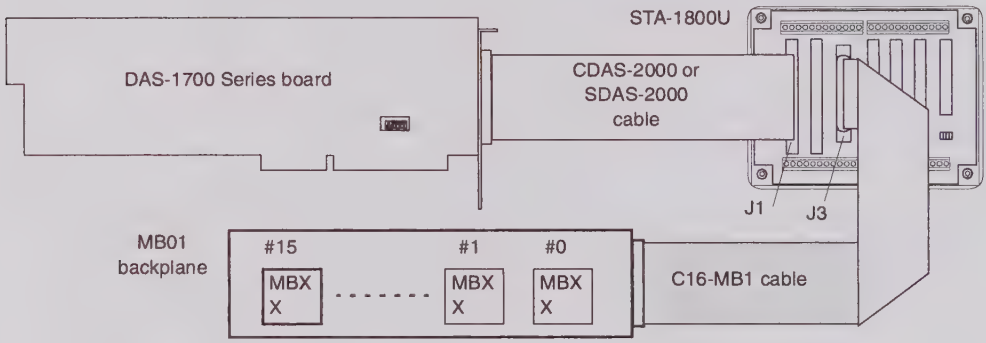


Figure 3-8. Attaching an MB01 Backplane to a DAS-1700 Series Board

MB02 Expansion Backplane

A DAS-1700 Series board configured for single-ended inputs and working through multiple STA-1800U screw terminal accessories can accept up to 16 MB02 expansion backplanes. Each STA-1800U contains four connectors (J4 to J7) for connecting up to four MB02 expansion backplanes. To attach MB02 expansion backplanes to an STA-1800U, use C-2600 cables, as shown in Figure 3-9. Refer to the *MB Series User's Guide* for more information about MB02 backplanes and modules.

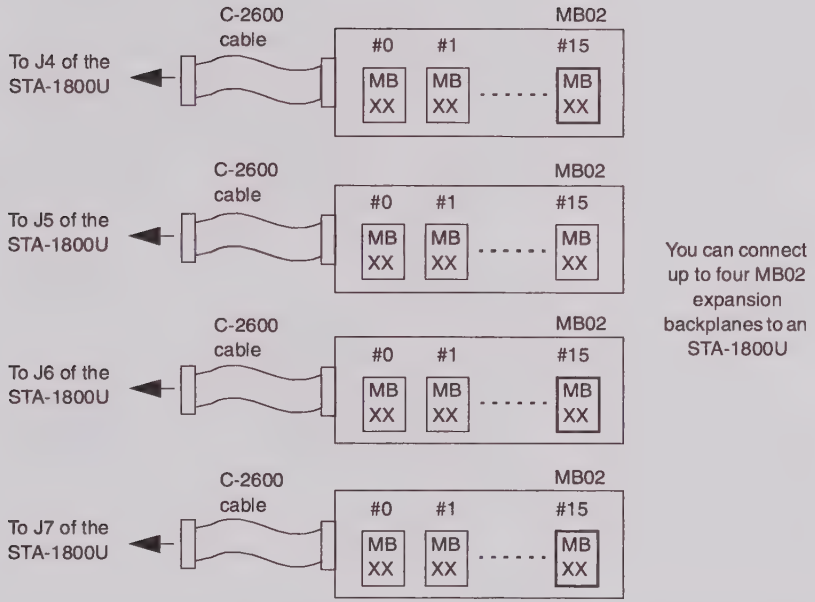


Figure 3-9. Attaching MB02 Expansion Backplanes to an STA-1800U

To attach additional MB02 expansion backplanes, daisy-chain additional STA-1800U screw terminal accessories to the first STA-1800U using CACC-2000 cables. Connect the J2 connector of one STA-1800U to the J1 connector of the next STA-1800U, as shown in Figure 3-10.

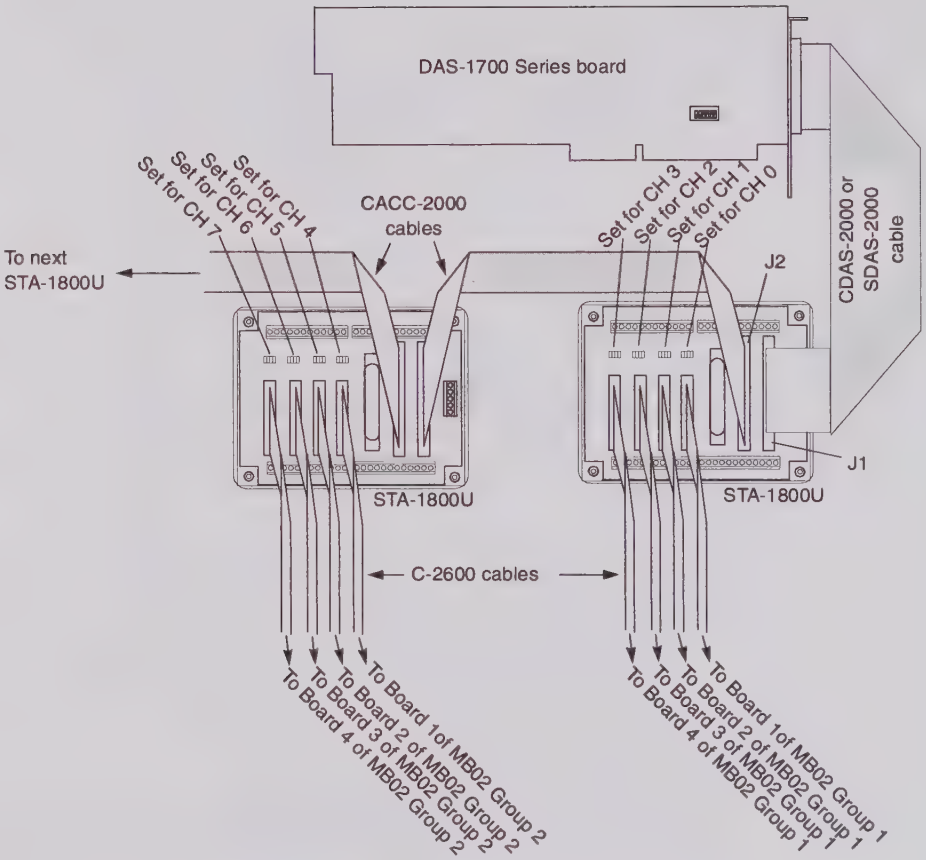

DAS-1700 Series board
CDAS-2000 or SDAS-2000 cable
CACC-2000 cables
To next STA-1800U
Set for CH 7
Set for CH 6
Set for CH 5
Set for CH 4
Set for CH 3
Set for CH 2
Set for CH 1
Set for CH 0
J2
J1
STA-1800U
STA-1800U
C-2600 cables
To Board 1 of MB02 Group 2
To Board 2 of MB02 Group 2
To Board 3 of MB02 Group 2
To Board 4 of MB02 Group 2
To Board 1 of MB02 Group 1
To Board 2 of MB02 Group 1
To Board 3 of MB02 Group 1
To Board 4 of MB02 Group 1

Figure 3-10. Daisy-Chaining STA-1800Us with Attached MB02s

The jumper pads beside connectors J4 to J7 on each STA-1800U screw terminal accessory select the channels of the DAS-1700 Series board that the attached MB02 expansion backplane is to use. On the first STA-1800U, the jumpers assign connectors J4 to J7 to DAS-1700 Series board channels 0 to 3, respectively (default settings), as shown in Figure 3-10. On the second STA-1800U, you must position the jumpers to assign connectors J4 to J7 to channels 4 to 7, respectively, and so on. Refer to Figure B-4 on page B-5 for a diagram of connectors J4 to J7 and their associated jumper pads.

EXP-1800 Expansion Accessory

To attach an EXP-1800 expansion accessory to the main I/O connector of a DAS-1700 Series board, use a CDAS-2000 or SDAS-2000 cable, as shown in Figure 3-11. To connect additional EXP-1800s, use CAB-50 Series cables, as shown in Figure 3-11. Refer to the *EXP-1800 User's Guide* for more information about EXP-1800 expansion accessories.

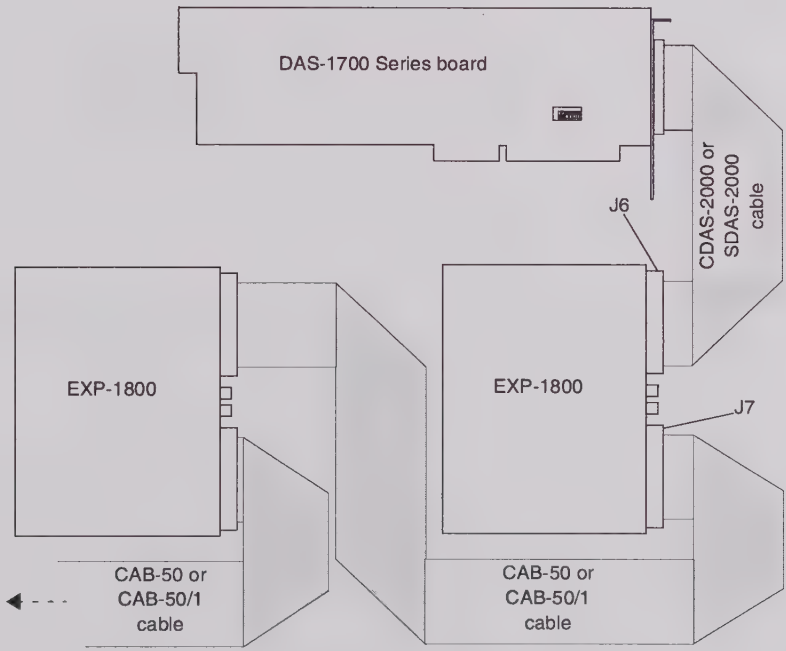


Figure 3-11. Daisy-Chaining EXP-1800s

You can attach up to 16 EXP-1800 expansion accessories to a DAS-1700 Series board; however, some of the added EXP-1800s will require external power. Each EXP-1800 contains screw terminals for attaching external power, a receptacle for a DC/DC converter, and a switch for changing between internal and external power.

Note: The accuracy of a DAS-1700HR Series board exceeds the accuracy of an EXP-1800 expansion accessory. Data returned by a DAS-1700HR Series board attached to an EXP-1800 using a gain of 1 is appropriate; however, data returned by a DAS-1700HR Series board attached to an EXP-1800 using a gain of 50 includes additional noise and other information that may not be significant.

Connecting Signals

Caution: To avoid electrical damage, turn power to the computer and any attached accessories OFF before wiring signals to the board.

Keep the following in mind when wiring signals to a DAS-1700 Series board:

- You wire your signal to a screw terminal on an accessory that is connected to the board through the main I/O connector. Figure B-1 on page B-2 lists the functions associated with each pin on the main I/O connector.
- DAS-1700 Series boards contain separate grounds for low-level analog signals, ±15 V power return, and digital signals. Use an analog ground (LL GND or U_CM MD, depending on the input configuration) for analog signals; use a ±15 V return for analog power; use a digital ground (DGND) for digital signals and the +5 V power-supply return.

  If you are using a differential input configuration, use LL GND for analog ground. If you are using a single-ended input configuration, you can use LL GND or U_CM MD for analog ground; refer to page 7-6 for information on choosing between available analog grounds.

- When using a DAS-1701ST, DAS-1701ST-DA, or DAS-1701AO board at a gain of 50 or 250, take the following precautions to avoid analog noise and performance degradation:
  - Operate the board in 8-channel differential mode. Using the board in 16-channel single-ended mode at high gains introduces enough ground-loop noise to produce large fluctuations in readings.
  - Minimize noise from crosstalk and induced-voltage pickup in the flat cables and screw terminal accessories by using shielded cable. Connect the shield to LL GND and the inner conductors to CH LO and CH HI. CH LO and LL GND should have a DC return (or connection) at some point; this return should be as close to the signal source as possible. Induced noise from RF and magnetic fields can easily exceed tens of microvolts, even on 1-foot or 2-foot cables; shielded cable eliminates this problem.
  - Avoid bi-metallic junctions in the input circuitry. For example, the kovar leads, used on reed relays, typically have a thermal emf to copper of 40 µV/°C. Thermals can introduce strange random variations caused by air currents and so on.
  - Provide filtering using either hardware (resistors, capacitors, and so on) or software. To provide software filtering, instead of reading the channel once, read it 10 or more times in quick succession and average the readings. If the noise is random and gaussian, the noise will be reduced by the square-root of the number of readings.
- Do not mix your analog input signals with the AC line. An inadvertent short between data and power lines can cause extensive and costly damage to your computer for which the manufacturer may not accept liability. To prevent this problem, use the following precautions:
  - Avoid direct connections to the AC line.
  - Make sure all connections are tight and sound so that signal wires are not likely to come loose and short to high voltages.
  - Use isolation amplifiers and transformers where necessary.

Single-Ended Analog Input Signals

Figure 3-12 illustrates how to connect an analog input signal to channel *n* on a DAS-1700 Series board configured for single-ended inputs.

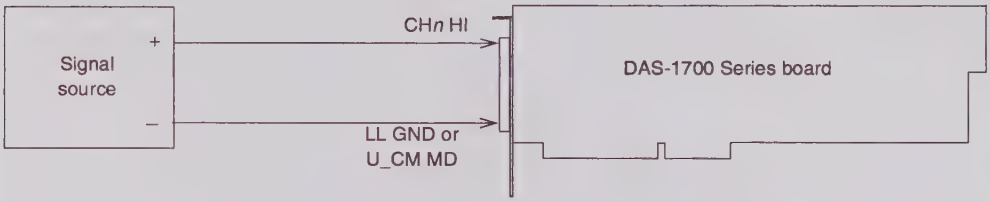


Figure 3-12. Single-Ended Inputs (Single Channel)

Notes: You specify the common-mode ground reference through software. If you specify a user-defined common-mode ground reference, use U_CM MD and make sure that the signal source is grounded. If you specify a low-level analog ground reference, use LL GND if the signal source is isolated; if the signal source is not isolated, make no connection.

It is recommended that you wire all unused channels to LL GND or U_CM MD to prevent the input amplifiers from saturating and to ensure the accuracy of your data.

Figure 3-13 illustrates how to connect analog input signals to channels 0 through *n*, where all channels are referred to the same user-defined common-mode ground. Note that the fixed potential from signal common to ground must be within the common-mode operating range (±10 V).

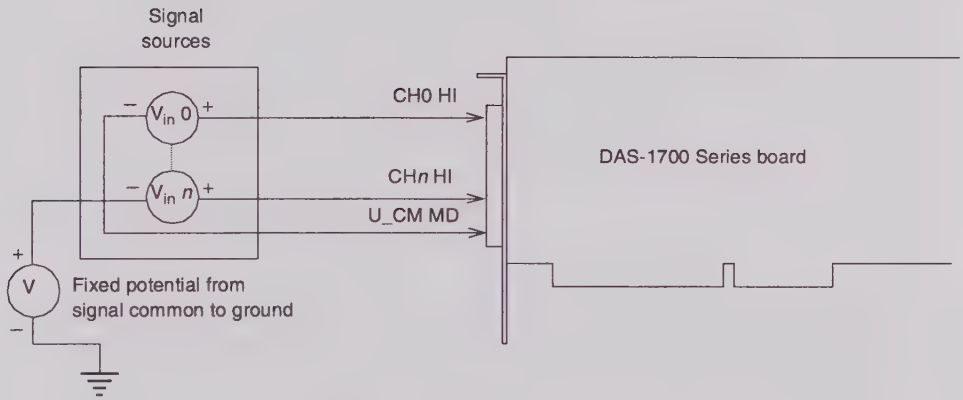


Figure 3-13. Single-Ended Inputs (Multiple Channels)

Differential Analog Input Signals

Figure 3-14 illustrates three ways to connect an analog input signal to channel *n* on a DAS-1700 Series board configured for differential inputs.

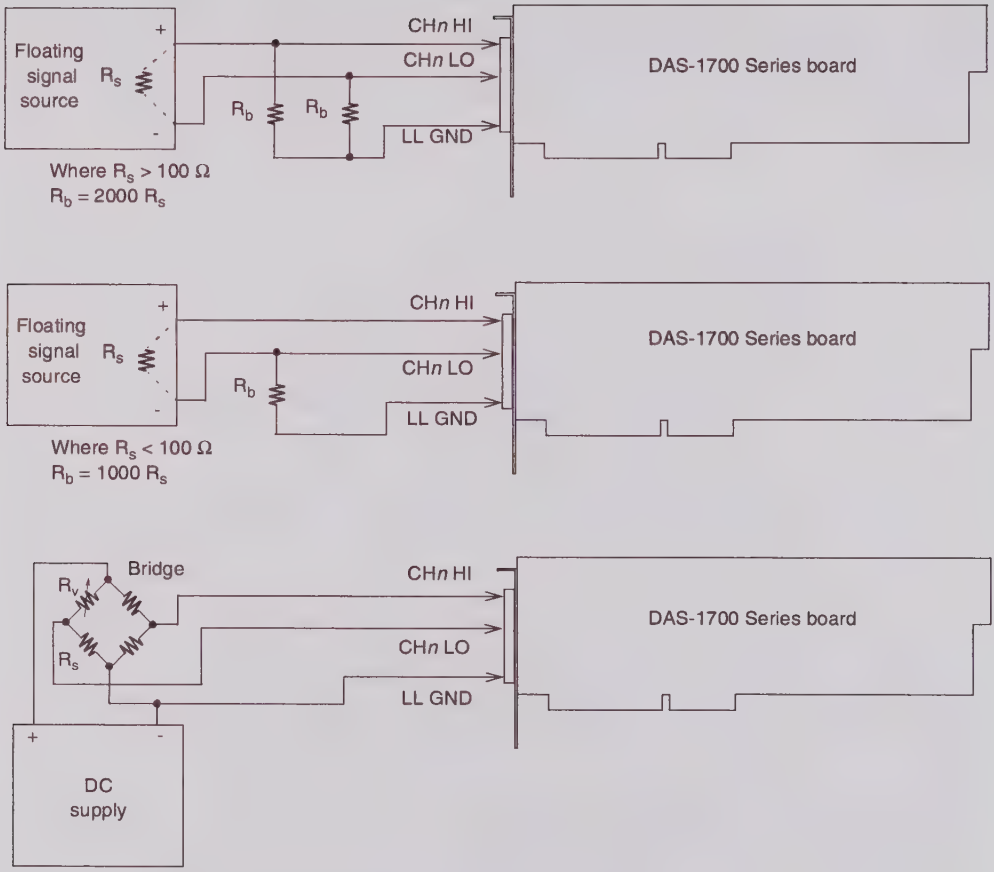


Figure 3-14. Differential Inputs

The upper two circuits of Figure 3-14 illustrate floating signal source connections. (A floating signal source is a voltage source that has no connection with earth ground; the signal is not referenced to the third wire on a 3-wire AC line outlet.) Floating signal sources require the addition of resistors to provide a bias current return.

You can determine the value of the bias return resistors (R_b) from the value of the source resistance (R_s), using the following relationships:

- When R_s is greater than 100 Ω, use the connections in the upper circuit. The resistance of each of the two bias return resistors must equal 2000 R_s.
- When R_s is less than 100 Ω, use the connections in the middle circuit. The resistance of the bias return resistor must be greater than 1000 R_s.

In the lower circuit of Figure 3-14, bias current return is inherently provided by the source. The circuit requires no bias resistors. R_s is the signal source resistance while R_v is the resistance required to balance the bridge.

Avoiding a Ground Loop Problem

If your signal source is grounded, the signal-source ground and the DAS-1700 Series board ground may not be at the same voltage level because of the distances between equipment wiring and the building wiring. In this situation, ground loop problems can occur if you tie the two grounds together and the two grounds are not at the same potential. The difference in potential is referred to as a *common-mode voltage* (V_{cm}) because it is normally common to both sides of a differential input (it appears between each side and ground).

The most effective way to avoid common-mode voltage errors for single-ended inputs is to wire the inputs as shown in Figure 3-12, using the U_CM MD input.

Since a differential input responds only to the difference in the signals at its high and low inputs, its common-mode voltages cancel out and leave only the signal. However, if your input connections create a ground loop, you could see incorrect data readings resulting from the difference between the signal source's ground potential and the DAS-1700 Series board's ground.

Figure 3-15 shows the proper way to connect a differential input to a grounded signal source. Make sure that CH*n* LO is connected to ground at the signal source, not at the computer and make sure that you do not tie the two grounds together.

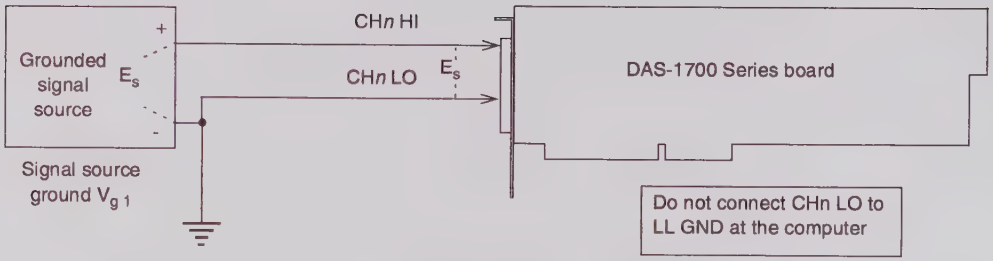


Figure 3-15. Avoiding a Ground Loop Problem

Analog Output Signals

Figure 3-16 illustrates how to connect a voltage output signal from DAC *n* on a DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR-DA, DAS-1701AO, or DAS-1702AO board to your application.

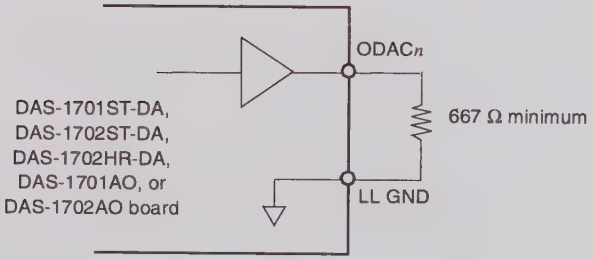


Figure 3-16. Voltage Output

Digital Signals

You can connect the following digital signals to a DAS-1700 Series board:

- **Digital input signal** - Connect a digital input signal to the DI0, DI1, DI2, or DI3 pin of the main I/O connector.
- **Digital output signal** - Connect a digital output signal to the DO0, DO1, DO2, or DO3 pin of the main I/O connector.
- **External pacer clock** - Connect an external pacer clock to the XPCLK pin of the line of the main I/O connector.
- **External digital trigger** - Connect an external digital trigger to the TGIN pin of the main I/O connector.
- **Hardware gate** - Connect a hardware gate to the TGIN pin of the main I/O connector.
- **SSH output signal** - Connect the SSH output signal to the SSHO pin of the main I/O connector.
- **Trigger/gate output signal** - Connect the trigger/gate output signal to the TGOUT pin of the main I/O connector.
- **Strobe signal** - Connect the strobe signal to the DOSTB pin of the main I/O connector.

Make sure that all digital signals are TTL-level compatible. Use the D GND pin as the return for all digital signals. Refer to Figure B-1 on page B-2 for the location of each pin on the main I/O connector.

Synchronizing the Start of Operations on Multiple Boards

You can synchronize the start of analog input operations on up to three DAS-1700 Series boards using trigger and gate signals from the main I/O connector. All boards can run at the same conversion rate or each board can run at a different conversion rate.

The internal A/D pacer clock is designed to be tightly coupled with trigger and gate operations. After a board receives the trigger or gate signal, conversions begin within a defined period of time. If each board is programmed for a different conversion rate, the first conversion on each board occurs after this time period and subsequent conversions occur at the programmed rate.

Figure 3-17 illustrates two ways to synchronize the start of analog input operations on multiple boards. Both use the internal A/D pacer clock to pace acquisitions.

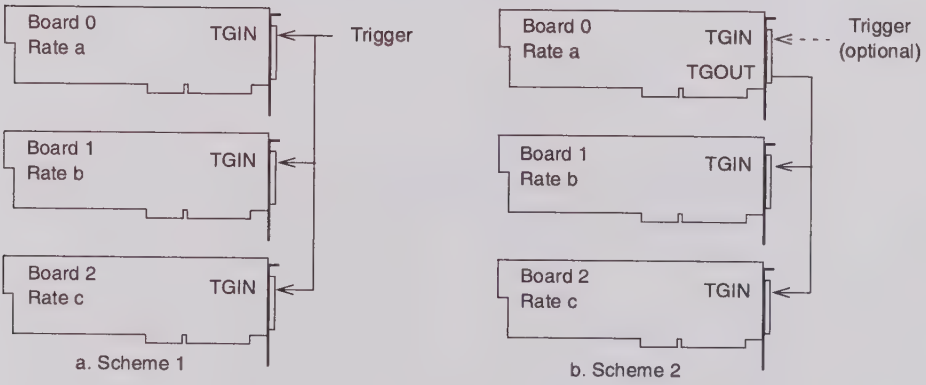


Figure 3-17. Synchronizing the Start of Operations on Multiple Boards

In scheme 1, you connect the trigger/gate inputs of the three boards together and start the analog input operation when an external digital trigger event occurs. A/D conversions on each board start 400 ±100 ns from the time the active edge of the trigger signal is detected. All conversions start within 100 ±100 ns of each other from board to board. When using scheme 1, you can use the internal A/D pacer clock or an external pacer clock.

In scheme 2, you start conversions either by an external digital trigger or through software. The boards are connected in a master/slave relationship; board 0 is the master, and boards 1 and 2 are the slaves.

If you use software to start A/D conversions for board 0 of scheme 2, the board 0 pacer clock starts and triggers conversions in the slave boards. However, board 0 conversions do not begin until after conversions begin in the slave boards. The delay of board 0 conversions is caused by a protection feature built into the register that creates software-triggered conversions; the function of the protection feature is to prevent false conversions.

If you use an external digital trigger for board 0 of scheme 2, the trigger/gate output signal (TGOUT) from board 0 triggers conversions in all three boards immediately. Note that TGOUT is an active, high-going signal. Therefore, you must program the slave-board TGIN inputs for a positive-edge trigger. Refer to page 7-30 for more information about the TGOUT signal.

When using scheme 2, you must use the internal A/D pacer clock.

4

Testing the Board

This chapter describes how to use the DAS-1700 Series Control Panel (CTL1700.EXE) to test the functions of DAS-1700 Series boards. The control panel is shipped with the ASO-1700 software package.

Note: Before using the control panel, it is recommended that you install the Keithley Memory Manager to ensure the allocation of a memory buffer large enough for control panel needs. Refer to Appendix C for more information about the Keithley Memory Manager.

To use the control panel, perform the following steps:

1. *If you are using Windows 3.1 or Windows for Workgroups 3.11*:

   – Double-click the control panel icon in the DAS-1700 program group.

   If you are using Windows 95:

   – Point to **Programs**, **Keithley DAS-1700**, and **DAS-1700 Control Panel** on the **Start** menu.

   The software displays the Open Configuration File dialog box, asking you to specify the configuration file to use.

2. Select the configuration file in one of the following ways:

   – To use the default configuration file DAS1700.CFG, click **OK**. Refer to Table 2-1 on page 2-5 for a list of the default configuration options.

   – Highlight or enter the name of another configuration file in the File Name box and click **OK**. The software uses the configuration options from the selected configuration file.

After you specify the appropriate configuration options, the software displays the main control panel for the first board (board 0) listed in the configuration file. The control panel allows you to acquire, read, and transfer data and to set up and display parameters.

3. Select the appropriate buttons to set up and perform an operation. For information about the meaning of the parameters, click **Help** on the control panel or refer to Chapter 7.

4. To set up and perform an analog output operation (if supported), click **Digital I/O and D/A** on the **Panels** menu. When the control panel displays the digital I/O and D/A panel for the board, click the appropriate buttons to proceed with your operation.

   When you have finished the analog output operation, click **Close** to return to the main control panel.

5. To set up and perform a digital I/O operation, click **Digital I/O (and D/A)** on the **Panels** menu. When the control panel displays the digital I/O (and D/A) panel for the board, click the appropriate buttons to proceed with your operation.

   When you have finished the digital I/O operation, click **Close** to return to the main control panel.

6. If desired, you can use Dynamic Data Exchange (DDE) to transfer data to another Windows program by clicking **DDE** from the **Panels** menu.

7. When you finish using the control panel, click **Exit** on the **File** menu to quit the program.

Note: If more than one board is configured in a configuration file, the control panel recognizes the first board and ignores the rest. If you want to test more than one board, you must configure the boards in multiple configuration files. Refer to page 2-5 for more information.

5

Troubleshooting

This chapter contains the following sections:

- **Identifying Symptoms and Possible Causes** - lists general symptoms and possible solutions for problems with DAS-1700 Series boards.
- **Testing the Board and the Computer** - helps you determine whether the problem is in the computer or in the DAS-1700 Series board.
- **Testing the Accessory Slot and I/O Connections** - helps you determine whether the problem is in the accessory slot or in the I/O connections.
- **Technical Support** - describes how to contact Keithley MetraByte for technical support.

Identifying Symptoms and Possible Causes

Table 5-1 lists general symptoms and possible solutions for problems with DAS-1700 Series boards.

Table 5-1. Troubleshooting Information

Symptom	Possible Cause	Possible Solution
Board does not respond	Base address is unacceptable.	Make sure that the base address specified in the configuration file matches the setting of the base address switch on the board. Make sure that no other system resource is using any of the 16 I/O locations beginning at the specified base address (all boards) and any of the 10 I/O locations beginning at the specified base address plus 400h (DAS-1700AO Series only). If necessary, reconfigure the base address. Refer to page 2-4 for instructions.
	The interrupt level is unacceptable.	Make sure no other system resource is using the interrupt level specified in the configuration file. If necessary, reset the interrupt level.
	The board configuration is incorrect.	Check the settings in the configuration file.
	The board is incorrectly aligned in the accessory slot.	Check the board for proper seating.
	The board is damaged.	Contact Keithley MetraByte for technical support; refer to page 5-5.
Intermittent operation	The I/O bus speed is in excess of 8 MHz.	Reduce I/O bus speed to a maximum of 8 MHz (to change the I/O bus speed, run BIOS setup). See your computer documentation for instructions on running BIOS setup.
	Vibrations or loose connections exist.	Cushion source of vibration and tighten connections.
	The board is overheating.	Check environmental and ambient temperature. See the documentation for your computer.
	Electrical noise exists.	Provide better shielding or reroute unshielded wiring.

Table 5-1. Troubleshooting Information (cont.)

Symptom	Possible Cause	Possible Solution
Data appears to be invalid	The I/O bus speed is in excess of 8 MHz.	Reduce I/O bus speed to a maximum of 8 MHz (to change the I/O bus speed, run BIOS setup). See the documentation for your computer for instructions on running BIOS setup.
	An open connection exists.	Check wiring to screw terminal.
	Another system resource is using the specified base address.	Reconfigure the base address of the board; refer to page 2-4 for information. Check the base address assignments of other system resources and reconfigure, if necessary.
	Transducer is not connected to the channel being read.	Check the transducer connections.
	Board is set for a single-ended input configuration while the transducer is set for a differential input configuration, or vice versa.	Check transducer specifications and board configuration.
Computer does not boot	Board not seated properly.	Check the installation of the board.
	The base address setting of the board conflicts with that of another system resource.	Check the base address settings of your system resources; each address must be unique.
	The power supply of the computer is too small to handle all the system resources.	Check the needs of all system resources and obtain a larger power supply.
System lockup	A timing error occurred.	Press **Ctrl + Break**.

If you cannot identify the problem using the information in Table 5-1, refer to the next section to determine whether the problem is in the computer or in the DAS-1700 Series board.

Testing the Board and the Computer

To determine whether the problem is in the computer or in the DAS-1700 Series board, perform the following steps:

Caution: Removing a board with the power ON can cause damage to your board and/or computer.

---

1. Turn the power to the computer OFF, and remove power connections to the computer.
2. While keeping connections to accessories intact, unplug the cable to the main I/O connector of the DAS-1700 Series board.
3. Remove the board from the computer and visually check for damage. If the board is obviously damaged, refer to page 5-5 for information on returning the board.
4. With the board out of the computer, check the computer for proper operation. Power up the computer and perform any necessary diagnostics.

If you have another DAS-1700 Series board that you know is functional, refer to the next section to determine whether the problem is in the accessory slot or in the I/O connections. If you do not have another board, refer to page 5-5 for information on how to contact Keithley MetraByte for technical support.

Testing the Accessory Slot and I/O Connections

To determine whether the problem is in the accessory slot or in the I/O connections, perform the following steps:

1. Turn the power to the computer OFF, and remove power connections to the computer.
2. Install a DAS-1700 Series board that you know is functional. Do not make any I/O connections.

3. Turn computer power ON and check operation with the functional board in place. This test checks the accessory slot. If you are using more than one board, use the functional board to test the other slots as well.
4. If the accessory slots are functional, use the functional board to check the I/O connections by reconnecting and checking the operation of the I/O connections, one at a time.
5. If operation fails for an I/O connection, check the individual inputs one at a time for shorts and opens.
6. If operation is normal, the problem is in one of the DAS-1700 Series boards originally in the computer. If you were using more than one board, try each board, one at a time, to determine which is faulty.
7. If you cannot isolate the problem, refer to the next section for instructions on getting technical support.

Technical Support

Before returning any equipment for repair, call Keithley MetraByte for technical support at:

(508) 880-3000

Monday - Friday, 8:00 A.M. - 6:00 P.M., Eastern Time

An applications engineer will help you diagnose and resolve your problem over the telephone.

Please make sure that you have the following information available before you call:

DAS-1700 Series board configuration	Model	_____
	Serial #	_____
	Revision code	_____
	Base address setting	_____
	Interrupt level setting	_____
	Number of channels	_____
	Input configuration	single-ended, differential
	Range type	unipolar, bipolar
	DMA chan(s)	_____
	Number of SSH-8s	_____
	Number of EXPs	_____
Computer	Manufacturer	_____
	CPU type	_____
	Clock speed (MHz)	_____
	KB of RAM	_____
	Video system	_____
	BIOS type	_____
Operating system	Windows version	_____
Software package	Name	_____
	Serial #	_____
	Version	_____
	Invoice/Order #	_____
Compiler (if applicable)	Language	_____
	Manufacturer	_____
	Version	_____
Accessories	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____

If a telephone resolution is not possible, the applications engineer will issue you a Return Material Authorization (RMA) number and ask you to return the equipment. Include the RMA number with any documentation regarding the equipment.

When returning equipment for repair, include the following information:

- Your name, address, and telephone number.
- The invoice or order number and date of equipment purchase.
- A description of the problem or its symptoms.
- The RMA number on the outside of the package.

Repackage the equipment, using the original anti-static wrapping, if possible, and handling it with ground protection. Ship the equipment to:

ATTN: RMA #_____
Repair Department
Keithley MetraByte
440 Myles Standish Boulevard
Taunton, Massachusetts 02780

Telephone (508) 880-3000
FAX (508) 824-5517

Notes: If you are submitting your equipment for repair under warranty, you must include the invoice number and date of purchase.

To enable Keithley MetraByte to respond as quickly as possible, you must include the RMA number on the outside of the package.

6

Calibrating the Board

This chapter contains the following sections:

- **Equipment Requirements** - lists the equipment you need to calibrate a DAS-1700 Series board.
- **Potentiometers and Test Points** - shows the location of the potentiometers and test points needed to calibrate a DAS-1700 Series board.
- **Calibration Utility** - describes how to use the DAS-1700 Series Calibration Utility.

Note: DAS-1700 Series boards and EXP expansion accessories are initially calibrated at the factory and should not require calibration when shipped. It is recommended that you check and, if necessary, readjust the calibration of your DAS-1700 Series board and EXP-1800 expansion accessories every six months.

Equipment Requirements

You need the following equipment to calibrate a DAS-1700 Series board:

- For DAS-1700ST Series and DAS-1700AO Series boards, a digital voltmeter accurate to 6 1/2 digits, such as a Keithley Instruments Model 196
- For DAS-1700HR Series boards, a digital voltmeter accurate to 7 1/2 digits, such as a Keithley Instruments Model 2001
- An adjustable ±10 V voltage calibrator, such as a Keithley Instruments Model 236
- An STA-1800U with a CDAS-2000 or SDAS-2000 cable, an STP-50 with a CDAS-2000 or SDAS-2000 cable, or a user-designed interface
- The appropriate number of CDAS-2000 or SDAS-2000 cables for EXP-1800 accessories, if used

Potentiometers and Test Points

The locations of the potentiometers and test points needed to calibrate DAS-1700 Series boards are shown in the following figures:

Board	Figure
DAS-1701ST DAS-1702ST	Figure 6-1 on page 6-3
DAS-1702HR	Figure 6-2 on page 6-3
DAS-1701ST-DA DAS-1702ST-DA	Figure 6-3 on page 6-4
DAS-1702HR-DA	Figure 6-4 on page 6-4
DAS-1701AO DAS-1702AO	Figure 6-5 on page 6-5

Figure 6-1. DAS-1701ST and DAS-1702ST

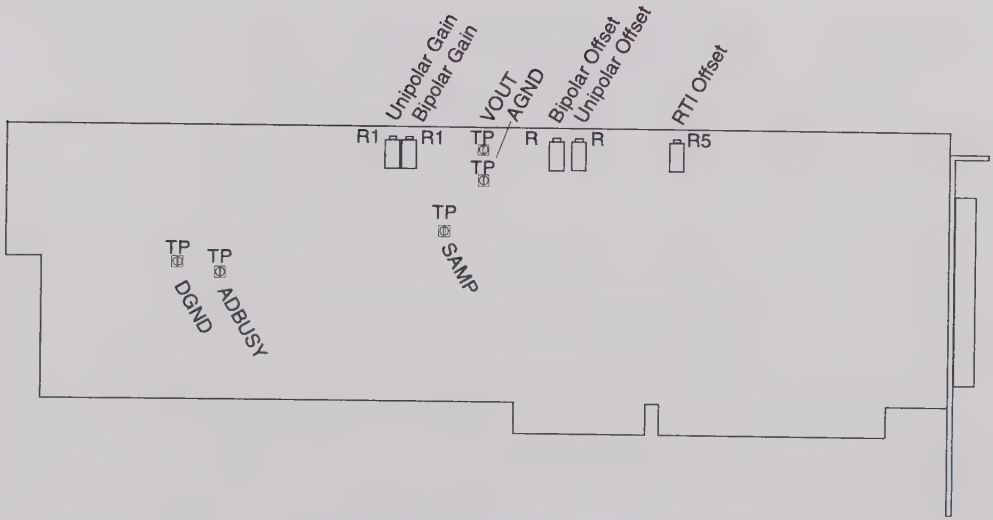


Figure 6-2. DAS-1702HR

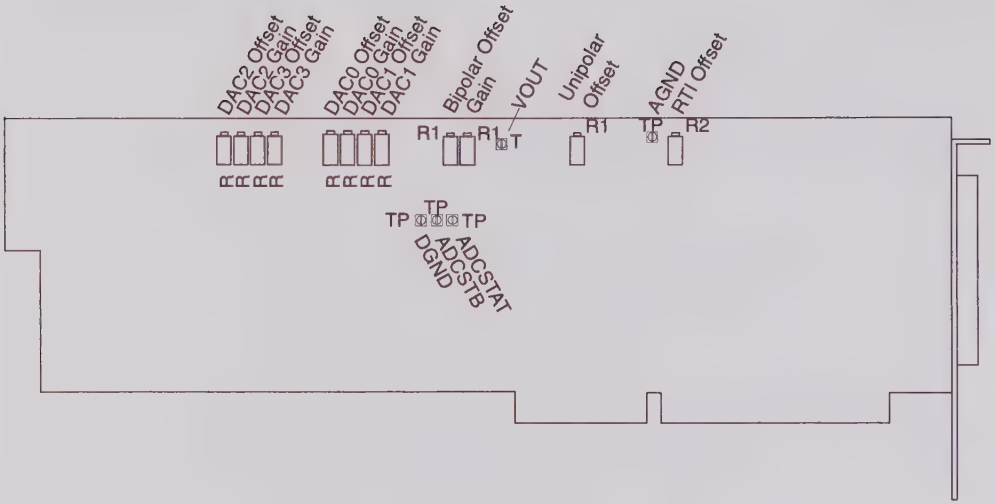


Figure 6-3. DAS-1701ST-DA and DAS-1702ST-DA

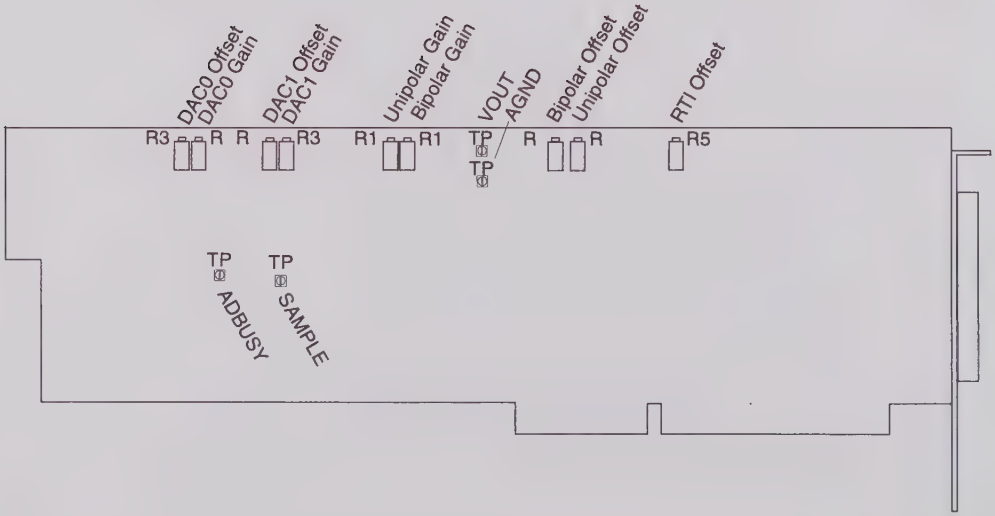


Figure 6-4. DAS-1702HR-DA

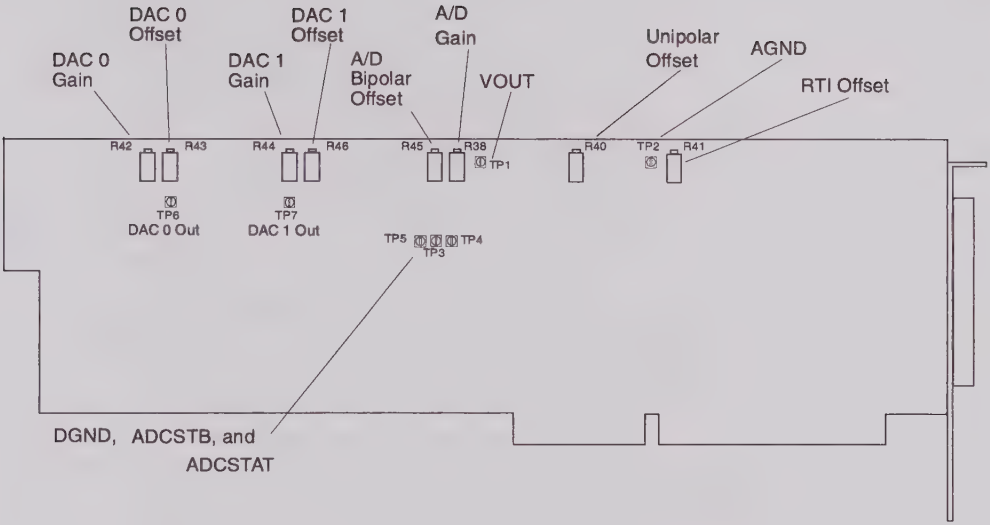


Figure 6-5. DAS-1701AO and DAS-1720AO

Calibration Utility

To calibrate a DAS-1700 Series board, use the DOS-based CAL1700.EXE calibration utility. The calibration utility is shipped with the ASO-1700 software package.

To use the calibration utility, perform the following steps:

1. Start the configuration utility from DOS or Windows as follows:
   - *From DOS*, change to the directory containing CAL1700.EXE and enter the following at the DOS prompt:

     ```
     CAL1700
     ```

   - *From Windows 3.1 or Windows 3.11 for Workgroups*, double-click the calibration utility icon in the DAS-1700 program group.
   - *From Windows 95*, point to **Programs**, **Keithley DAS-1700**, and **DAS-1700 Calibration** on the **Start** menu.

The software displays the calibration panel for the first board in the configuration file.

2. Follow the prompts as they appear on the calibration panel; the program guides you through the calibration process.

   If you want to calibrate another board, use the Board down arrow to select the appropriate board.

   If you are using EXP-1800 expansion accessories, do not connect them to the board until you are requested to do so by the calibration utility.

   For more information, click **Help** on the appropriate panel.

3. When you finish calibrating your boards, click **Exit** on the **File** menu to quit the program.

Note: If you are using EXP-1800 expansion accessories, it is recommended that you connect and calibrate one EXP-1800 at a time.

7

Functional Description

This chapter contains the following sections:

- **Block Diagrams** - functional block diagrams of DAS-1700 Series boards.
- **Analog Input Features** - a detailed description of the analog input features of DAS-1700 Series boards.
- **Analog Output Features** - a detailed description of the analog output features of DAS-1700 Series boards.
- **Digital I/O Features** - a detailed description of the digital I/O features of DAS-1700 Series boards.
- **Interrupts** - a description of the use of interrupts on DAS-1700 Series boards.
- **Power** - a description of the power features of DAS-1700 Series boards.

Block Diagrams

This section contains block diagrams for the following boards:

Boards	Page Number
DAS-1701ST, DAS-1702ST, and DAS-1702HR	Figure 7-1 on page 7-2
DAS-1701ST-DA and DAS-1702ST-DA	Figure 7-2 on page 7-3
DAS-1702HR-DA	Figure 7-3 on page 7-4
DAS-1701AO and DAS-1702AO	Figure 7-4 on page 7-5

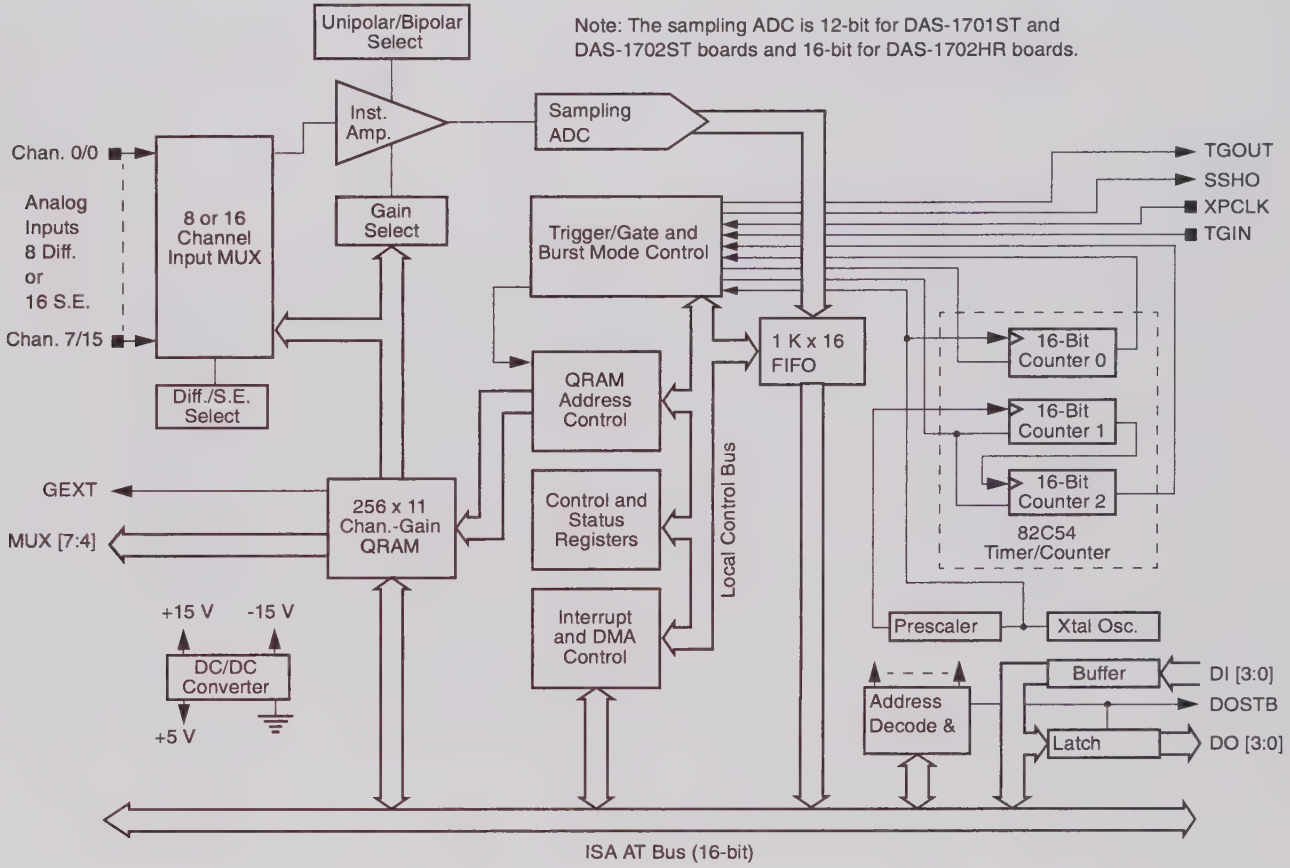


Figure 7-1. Block Diagram of DAS-1701ST, DAS-1702ST, and DAS-1702HR Board

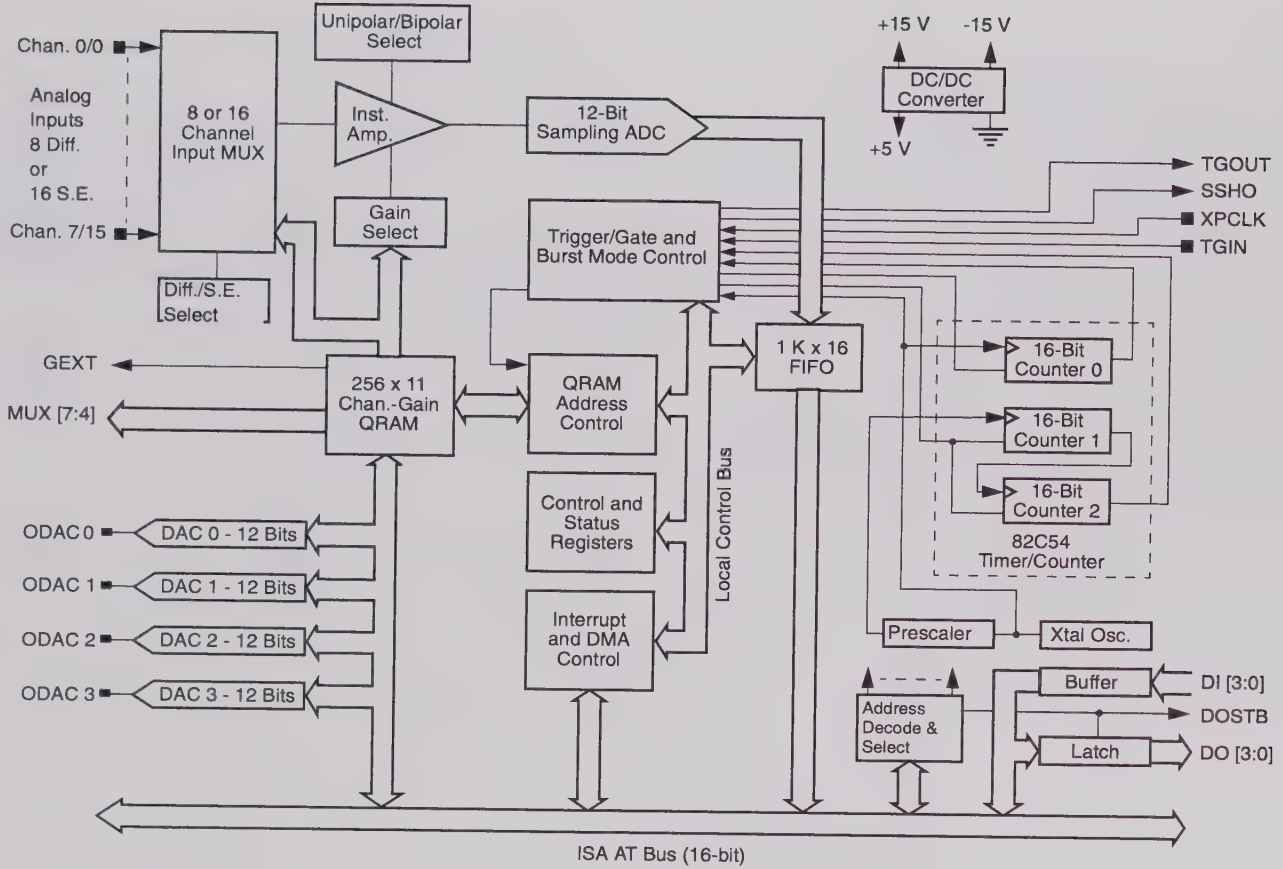


Figure 7-2. Block Diagram of DAS-1701ST-DA and DAS-1702ST-DA Board

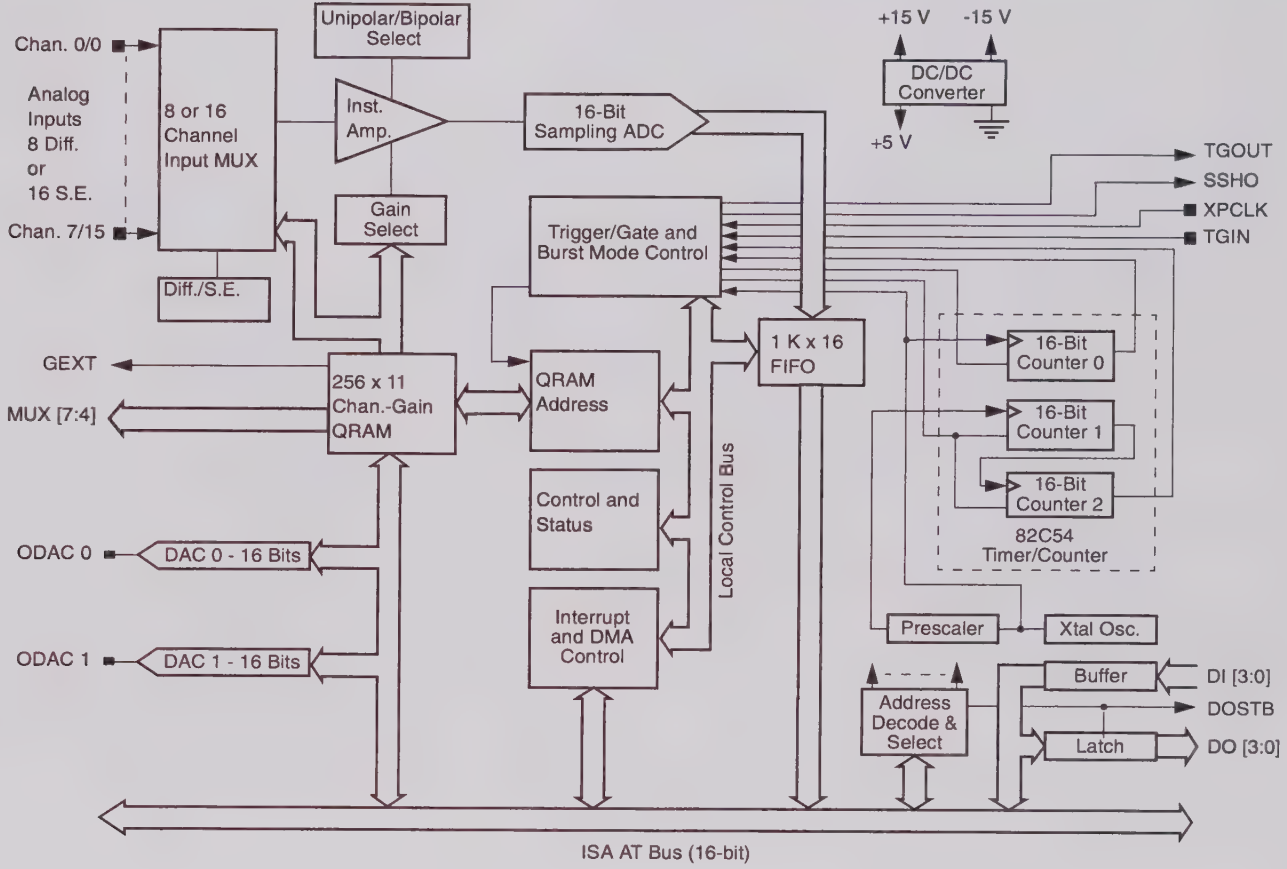


Figure 7-3. Block Diagram of DAS-1702HR-DA Board

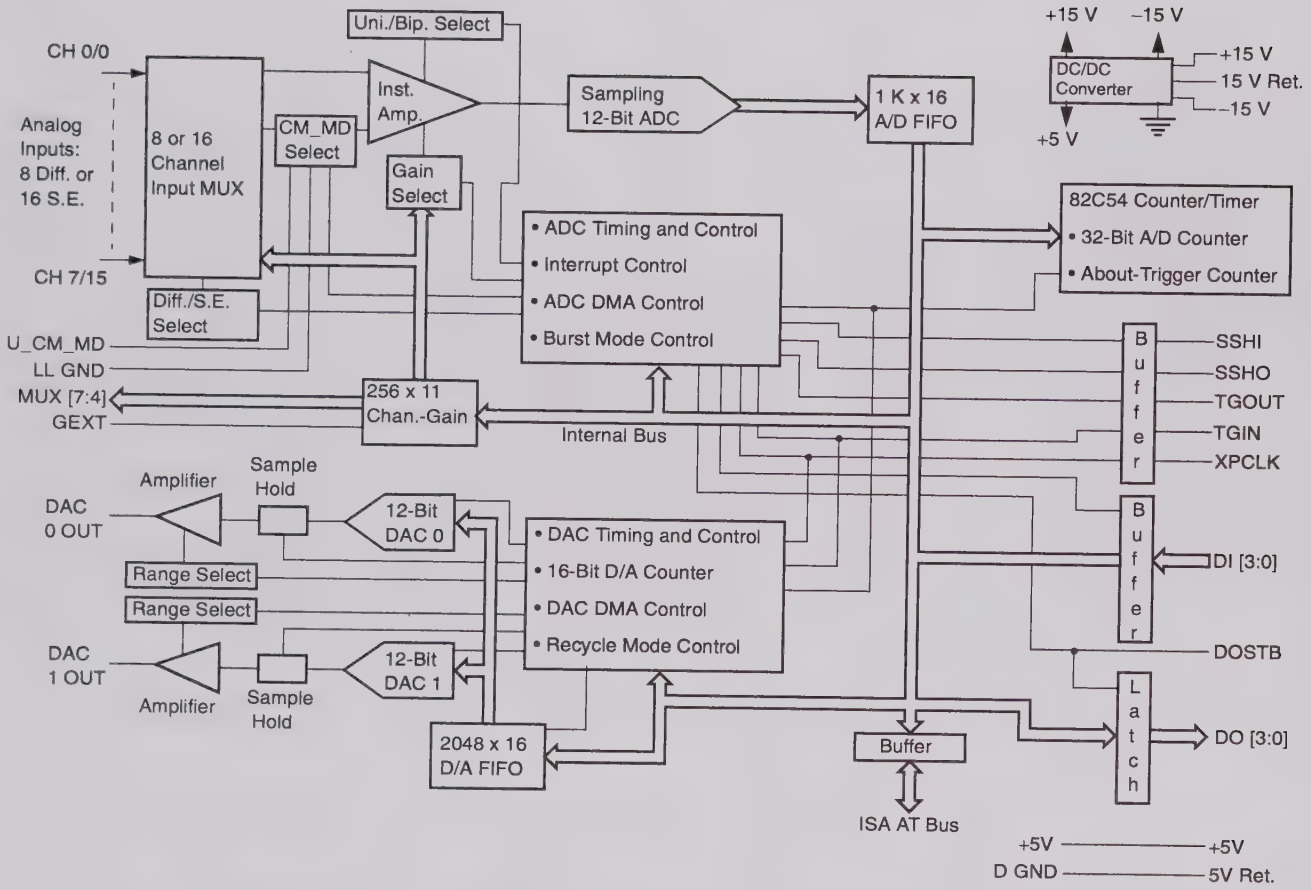


Figure 7-4. Block Diagram of DAS-1701AO and DAS-1702AO Board

Analog Input Features

The analog input section of DAS-1700 Series boards multiplexes all the active input channels (up to 16 single-ended or eight differential) down to a single, sampling ADC (analog-to-digital converter). Sampling resolution of the ADC is 12 bits (one part in 4096) for DAS-1700ST and DAS-1700AO Series boards and 16 bits (one part in 65,536) for the DAS-1700HR Series boards. The analog input features are described in the following sections.

Channels

This section describes the input configurations supported, channel expansion, gains and input ranges supported, and channel selection.

Input Configuration

Through software, you configure DAS-1700 Series boards for either 16 single-ended or eight differential onboard analog input channels. The differences between a single-ended and a differential input configuration are described in the following sections.

Single-Ended Input Configuration

A single-ended input configuration is appropriate if you are measuring high-level signals where noise is not significant, if the source of the input signal is close to the board, and if all input signals are referred to the same common ground.

You can use either a low-level analog ground or a user-defined common mode as the common-mode ground reference. (You specify the ground reference through software.) If you use a low-level analog ground, the low side of the instrumentation amplifier is connected to the LL GND pin; if you use a user-defined common mode, the low side of the amplifier is connected to the U_CM MD pin.

The user-defined common mode can eliminate ground loops in the system. Since the U_CM MD pin connects to the high input impedance of the instrumentation amplifier, the signal contains no power-supply return current.

The user-defined common mode is also useful when signals are referred to a voltage that is not ground or when the output range does not include ground. For example, a common way to perform 4 to 20 mA current monitoring is to connect a loop with a 250 Ω resistor to ground; the resistor yields a 1 to 5 V output in this current range. This method works but uses only 80% of the input range when connected to a 0 to 5 V range. A better way is to use a 312.5 Ω resistor and refer all measurements to 1.25 V. The actual output voltage then ranges from 1.25 V to 6.25 V; however, since the amplifier low side is connected to 1.25 V, the measurement range is now a span of 5 V, making the entire input range available and increasing resolution of the measurements by 20%.

It is recommended that you always use the user-defined common mode. Use analog ground only if you want the convenience of not having to connect a separate wire for low input.

Differential Input Configuration

A differential input configuration is appropriate if you are measuring low-level signals (less than 100 mV) where noise is a significant part of the signal or if common-mode voltages exist between the voltage source and the computer's chassis ground.

Channel Expansion

If you require additional analog input channels, you can use up to 16 EXP-1800 expansion accessories or up to 16 MB02 expansion backplanes to increase the number of available channels to 256. Refer to page 3-11 for more information on using EXP-1800 expansion accessories; refer to page 3-8 for more information on using MB02 expansion backplanes.

DAS-1700 Series boards use the following control lines to determine the channel sequence and gain settings for expansion channels:

- **Multiplexer control lines MUX 4 to MUX 7** - MUX 4 to MUX 7 determine the order in which channels on EXP-1800 expansion accessories and MB02 expansion backplanes are sampled.
- **External gain control line GEXT** - GEXT sets the gain of each channel on a EXP-1800 expansion accessory to 1 or 50.

Notes: If you use EXP-1800 expansion accessories or MB02 expansion backplanes, channels on the DAS-1700 Series board must be configured as single-ended.

If you are using a DAS-1700HR Series board with an EXP-1800 expansion accessory, keep in mind that the accuracy of the DAS-1700HR Series board exceeds the accuracy of the EXP-1800; therefore, data returned by a DAS-1700HR Series board attached to an EXP-1800 using a gain of 50 includes additional noise and other information that may not be significant.

Gains and Ranges

Each channel on a DAS-1700 Series board can measure analog input signals in one of eight unipolar and bipolar ranges. A unipolar signal is always positive (0 to 5 V, for example), while a bipolar signal can swing up and down between positive and negative peak values (±5 V, for example). DAS-1700 Series boards use positive magnitude to represent unipolar input signals and twos complement to represent bipolar input signals.

Through software, you specify the input range type (unipolar or bipolar) of the board and the gain of each channel on the board. Table 7-1 lists the gains supported by DAS-1700 Series boards and the analog input range for each gain. Note that for a given range with the same peak voltage, the unipolar input range type doubles the resolution of the ADC.

Table 7-1. Analog Input Ranges

Board	Location of Channel	Gain	Analog Input Range	
			Bipolar	Unipolar
DAS-1701ST DAS-1701ST-DA DAS-1701AO	Either onboard or on an EXP-1800 using a gain of 1	1	±5 V	0 to 5 V
		5	±1 V	0 to 1 V
		50	±100 mV	0 to 100 mV
		250	±20 mV	0 to 20 mV
	On an EXP-1800 using a gain of 50	50	±0.1 V	0 to 0.1 V
		250	±20 mV	0 to 20 mV
		2500	±2 mV	0 to 2 mV
		12.5k	±0.4 mV	0 to 0.4 mV
DAS-1702ST DAS-1702ST-DA DAS-1702HR[1] DAS-1702HR-DA[1] DAS-1702AO	Either onboard or on an EXP-1800 using a gain of 1	1	±10 V	0 to 10 V
		2	±5 V	0 to 5 V
		4	±2.5 V	0 to 2.5 V
		8	±1.25 V	0 to 1.25 V
	On an EXP-1800 using a gain of 50	50	±0.2 V	0 to 0.2 V
		100	±0.1 V	0 to 0.1 V
		200	±50 mV	0 to 50 mV
		400	±25 mV	0 to 25 mV

Notes

[1] If you use these boards with an EXP-1800 using a gain of 50, the data returned includes additional noise and other information that may not be significant.

Channel Selection

DAS-1700 Series boards can acquire data from a single analog input channel, from a group of consecutive analog input channels using automatic channel scanning, or from a group of analog input channels using the hardware channel-gain queue. These methods of channel selection are described in the following sections.

Selecting a Single Channel

You use software to specify a single channel and initiate a conversion.

Selecting Channels Using Automatic Channel Scanning

You use software to specify the first and last channels in a range of consecutive channels. The channels are sampled in order from first to last; the hardware automatically increments the analog input multiplexer address shortly after the start of each conversion. When the last address is reached, the multiplexer returns to the start address and the channels are sampled again. For example, assume that the start channel is 4, the stop channel is 7, and you want to acquire five samples. Your program reads data first from channel 4, then from channels 5, 6, and 7, and finally from channel 4 again.

The start channel can be higher than the stop channel. For example, assume that you are not using any expansion accessories, the board uses a differential configuration, the start channel is 7, the stop channel is 2, and you want to acquire five samples. Your program reads data first from channel 7, then from channels 0, 1, and 2, and finally from channel 7 again.

When using automatic channel scanning, all consecutive channels have the same gain (analog input range).

Selecting Channels Using the Channel-Gain Queue

You can use the hardware channel-gain queue to acquire samples from up to 256 logical channels. Through software, you specify the channels you want to sample, the order in which you want to sample them, and the gain for each channel.

You can set up the channels in the channel-gain queue either in consecutive order or in nonconsecutive order. You can also specify the same channel more than once. The channels are sampled in order from the first channel in the queue to the last channel in the queue.

Refer to Table 7-1 on page 7-9 for a list of the analog input ranges supported by DAS-1700 Series boards and the gains associated with each range.

Note that the throughput is likely to drop if you group channels with varying gains in sequence. The drop occurs because the channels with low-level inputs (magnitude of 100 mV or less) are slower than those with high-level inputs and because the channels with low-level inputs must drive out the residual signals left by the high-level inputs. The best way to maximize throughput is to use a combination of appropriate channel grouping and external signal conditioning. When using the channel-gain queue, consider the following suggestions:

- Keep all channels configured for a particular range together, even if you have to arrange the channels out of sequence.
- If your application requires high-speed scanning of low-level signals, use external signal conditioning to amplify the signal to ±5 V or 0 to 5 V. This increases total system throughput and reduces noise.
- If you are not using all the channel-gain entries (256), make a particular channel-gain entry twice to allow for settling time. In this case, ignore the results of the first entry.
- If you are measuring steady-state signals, do not use the channel-gain queue. Instead, use software to step through the channels and perform single-channel acquisitions. For example, using software-controlled single-channel acquisitions to acquire 1000 samples on channel 0 at a gain of 1 and then 2000 samples on channel 1 at a gain of 250 virtually eliminates interference. This method is best for measuring steady-state signals even if all the channels are at the same gain.
- If you are measuring low-level signals (±20 mV, 0 to 20 mV, ±100 mV, or 0 to 100 mV ranges) with a DAS-1701ST or DAS-1701AO board, reduce the effects of noise by sampling the same channel multiple times and then averaging the readings from each channel. In addition, use low-level transducers with signal conditioning and use the ±20 mV, 0 to 20 mV, ±100 mV, and 0 to 100 mV ranges with a differential input configuration.

Table 7-2 lists the maximum throughput for channel-to-channel sampling with a fixed analog input range (0.024% maximum error).

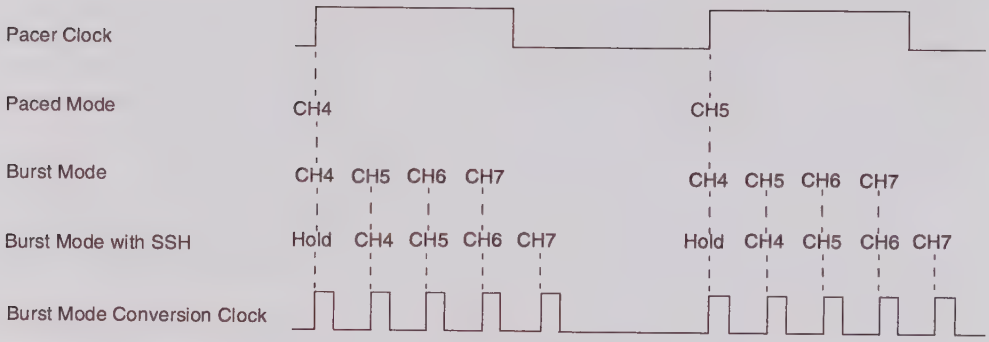


Figure 7-5. Conversion Modes

Paced Mode

Use paced mode if you want to accurately control the period between conversions of individual channels in a scan. The conversion rate equals the pacer clock rate. The sample rate, which is the rate at which a single channel is sampled, is the pacer clock rate divided by the number of channels you are sampling.

Burst Mode

Use burst mode if you want to accurately control both the period between conversions of individual channels in a scan and the period between conversions of the entire scan. Each pulse from the pacer clock starts a scan of channels. The conversion rate equals the rate of the burst mode conversion clock. The sample rate, which is the rate at which a single channel is sampled, equals the pacer clock rate.

The sample rate (pacer clock rate) should be no more than the burst mode conversion clock rate divided by the number of channels in the burst.

Burst Mode with SSH

Use burst mode with SSH if you want to accurately control both the period between conversions of individual channels in a scan and the period between conversions of the entire scan and if you want to simultaneously sample all channels in a scan. Each pulse from the pacer clock starts a simultaneous scan of all channels. The conversion rate equals the rate of the burst mode conversion clock. The sample rate, which is the rate at which a single channel is sampled, equals the pacer clock rate.

One extra tick of the burst mode conversion clock is required to sample and hold the values. Therefore, the sample rate (pacer clock rate) can be no more than the burst mode conversion rate divided by the sum of one plus the number of channels in the burst.

You cannot use burst mode with SSH for DAS-1700HR Series boards.

For information on the signal interface between DAS-1700ST Series and DAS-1700AO Series boards and SSH hardware, refer to page 7-32.

Clock Sources

DAS-1700 Series boards provide two clocks: a pacer clock and a burst mode conversion clock. In paced mode, you use only a pacer clock, as shown in Figure 7-5 on page 7-14. In burst mode and burst mode with SSH, you use both a pacer clock and the burst mode conversion clock, as shown in Figure 7-5 on page 7-14. These clock sources are described in the following sections.

Pacer Clock

In paced mode, the pacer clock determines the period between the conversion of one channel and the conversion of the next channel. In burst mode and burst mode with SSH, the pacer clock determines the period between the conversions of one scan and the conversions of the next scan. Through software, you select either the internal A/D pacer clock or an external pacer clock. These pacer clocks are described in the following sections.

Note: The rate at which the computer can reliably read data from a DAS-1700 Series board depends on a number of factors, including your computer, the operating system/environment, whether you are acquiring samples from multiple channels, the gains of the channels, whether you are using expansion accessories, and software issues. Make sure that the pacer clock does not initiate conversions too fast.

Internal A/D Pacer Clock

The internal A/D pacer clock uses two cascaded counters of the onboard 82C54 counter/timer and a crystal-controlled 5 MHz time base. The maximum available rate is 166.67 ksamples/s for DAS-1700ST and DAS-1700AO Series boards and 50 ksamples/s for DAS-1700HR Series boards; the minimum available rate is 0.0012 samples/s. When not used to pace analog input operations, you can use the internal A/D pacer clock to pace other events, such as digital I/O operations.

External Pacer Clock

The external pacer clock source is an externally applied TTL-compatible signal attached to the XPCLK pin (pin 44 of the board's main I/O connector or pin 38 of STA-1800U connectors J1 and J2). The polarity (active edge) of the external pacer clock is software-selectable.

An external pacer clock is useful if you want to pace at rates not available with the internal A/D pacer clock, if you want to pace at uneven intervals, or if you want to pace on the basis of an external event. By attaching the same external pacer clock to the XPCLK pins of multiple boards, you can synchronize all the boards to the external pacer clock.

Burst Mode Conversion Clock

In burst mode and burst mode with SSH, the burst mode conversion clock determines the period between the conversion of one channel in a scan and the conversion of the next channel in the scan. (The burst mode conversion clock is not used for paced mode.)

The maximum allowable rate is 166.67 ksamples/s for DAS-1700ST and DAS-1700AO Series boards and 50 ksamples/s for DAS-1700HR Series boards; the minimum available rate is 15.625 ksamples/s.

Triggers

A trigger is an event that occurs based on a specified set of conditions. An operation must have a start trigger to determine when acquisitions start. In addition, you can use an optional second trigger, the about trigger, to determine when acquisitions stop.

The following sections describe the supported trigger sources and the ways to acquire data using triggers.

Trigger Sources

The start trigger can be a software trigger or an external digital trigger. The about trigger, if used, is always an external digital trigger.

Note: DAS-1700 Series boards do not provide a hardware-based analog trigger. However, you can program an analog start trigger through software, using one of the analog input channels as the trigger channel. The DAS-1700 Series Function Call Driver provides functions for an analog trigger; refer to the *DAS-1700 Series Function Call Driver User's Guide* for more information.

The software trigger and external digital trigger are described in the following sections.

Software Trigger

A software trigger event occurs when you start the analog input operation (the computer issues a write to allow conversions). The point at which conversions begin depends on the pacer clock; refer to page 7-15 for more information. Note that the delay between the point at which you start the analog input operation and the point at which the internal A/D pacer clock starts is less than 1 µs.

External Digital Trigger

An external digital trigger event occurs when the DAS-1700 Series board detects either a negative edge or a positive edge at the TGIN pin (pin 46 of the board's main I/O connector or pin 42 of STA-1800U connectors J1 and J2). The trigger signal is TTL-compatible and the polarity (active edge) is software-selectable.

The point at which conversions begin depends on the pacer clock, as follows:

- **Internal A/D pacer clock** - The 82C54 counter/timer is idle until the trigger event occurs. Within 400 ns, the first conversion begins. Subsequent conversions are synchronized to the internal A/D pacer clock.
- **External pacer clock** - Conversions are armed when the trigger event occurs; conversions begin with the next active edge of the external pacer clock and continue with each subsequent active edge.

Figure 7-6 illustrates how conversions are initiated when using an external digital trigger.

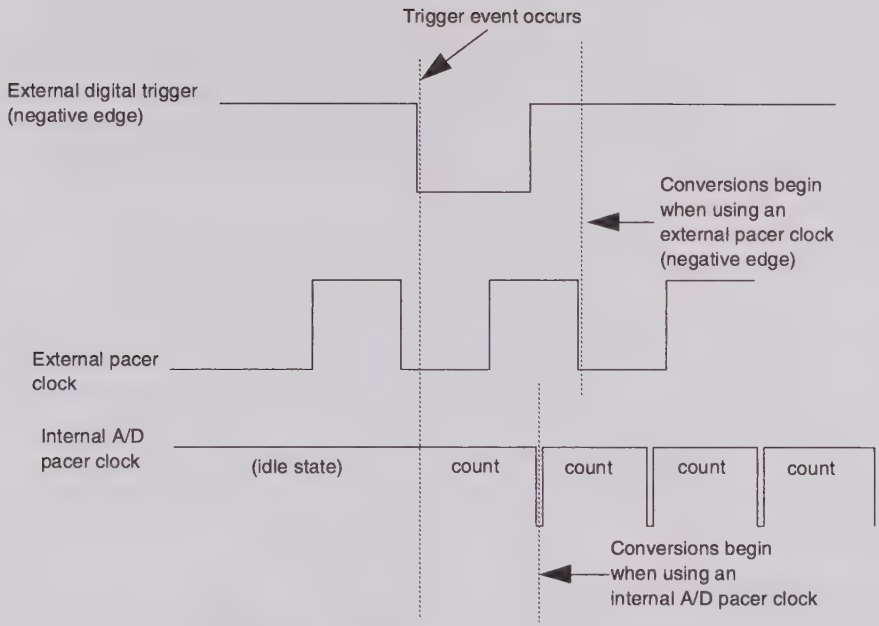


Figure 7-6. Initiating Conversions with an External Digital Trigger

The about trigger is always an external digital trigger. If you specify an about trigger, the operation stops when a specified number of samples has been acquired after the external digital trigger event.

Trigger Acquisition

The ways you can acquire data using triggers are described in the following sections.

Post-Trigger Acquisition

Use post-trigger acquisition in applications where you want to collect data after a specific trigger event. You specify a start trigger to determine when the operation starts. The operation stops either when the specified number of samples has been acquired or through a software command.

Pre-Trigger Acquisition

Use pre-trigger acquisition in applications where you want to collect data before a specific trigger event. You specify a start trigger and an about trigger. The start trigger determines when the operation starts. The operation stops when the about-trigger event occurs. Pre-trigger acquisition is available only when you use the DMA resources of the board.

About-Trigger Acquisition

Use about-trigger acquisition in applications where you want to collect data both before and after a specific trigger event. You specify a start trigger and an about trigger. The start trigger determines when the operation starts. The operation stops after a specified number of samples has been acquired after the about-trigger event occurs. About-trigger acquisition is available only when you use the DMA resources of the board.

Hardware Gate

A hardware gate is an externally applied digital signal that determines whether conversions occur. You connect the gate signal to the TGIN pin (pin 46 of the board's main I/O connector or pin 42 of STA-1800U connectors J1 and J2).

If you specify a positive gate, conversions occur only if the signal to TGIN is high; if the signal to TGIN is low, conversions are inhibited. If you specify a negative gate, conversions occur only if the signal to TGIN is low; if the signal to TGIN is high, conversions are inhibited. The gate signal is TTL-compatible and the polarity of the hardware gate is software-selectable.

The way conversions are synchronized depends on whether you are using the internal A/D pacer clock or an external pacer clock, as follows:

- **Internal A/D pacer clock** - The 82C54 counter/timer stops counting when the gate signal goes inactive. When the gate signal goes active, the 82C54 is reloaded with its initial count value and starts counting again; therefore, conversions are synchronized to the gate signal.
- **External pacer clock** - The signal from the external pacer clock continues uninterrupted while the gate signal is inactive; therefore, conversions are synchronized to the external pacer clock.

Figure 7-7 illustrates the use of a hardware gate.

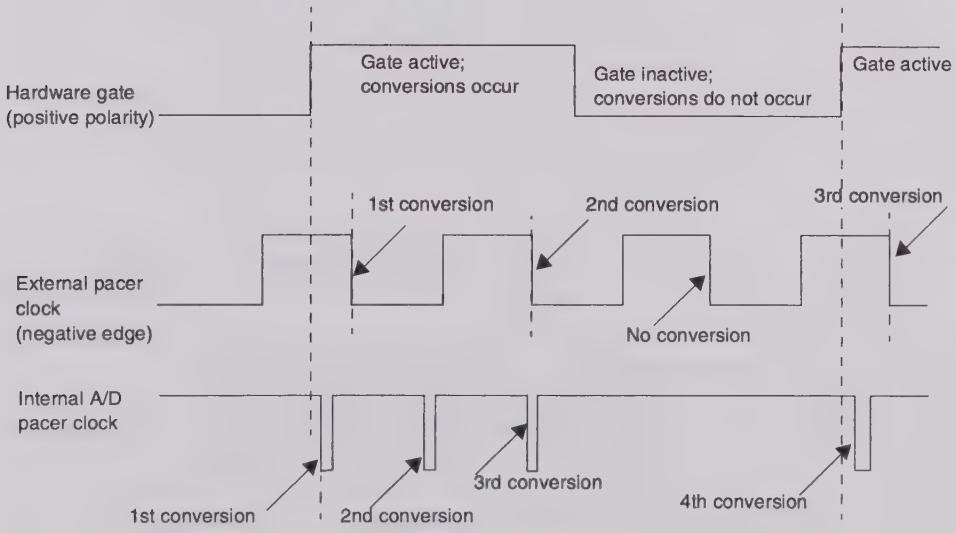


Figure 7-7. Hardware Gate

Data Transfer

DAS-1700 Series boards contain a 1024-word A/D FIFO. The result of each A/D conversion is automatically stored in the FIFO. You can transfer data from the A/D FIFO to computer memory using either interrupts or the DMA resources of the board, as described in the following sections.

Using Interrupts

You can program the board to generate an interrupt anytime the A/D FIFO contains data (FIFO Not Empty) or after the A/D FIFO accumulates 512 A/D samples (FIFO Half Full). An interrupt service routine can then transfer data from the A/D FIFO to computer memory while the FIFO continues to fill. Refer to page 7-33 for more information about interrupts.

The interrupt level (3, 5, 7, 10, 11, or 15) is software-selectable. Refer to page 2-5 for information on specifying the interrupt level.

Unpredictable interrupt latencies in Windows can make maximum board speeds unachievable; therefore, it is recommended that you use single-channel or dual-channel DMA instead of interrupts, if possible.

Using DMA Resources

You can use the DMA controller to bypass the CPU and transfer data directly from a DAS-1700 Series board to computer memory. The ability to run independent of the CPU and at high-transfer rates makes DMA an attractive method for transferring data in data acquisition systems.

DAS-1700 Series boards use DMA channel 5, 6, or 7 to perform single-channel DMA transfers or DMA channel pairs 5 and 6, 6 and 7, or 7 and 5 to perform dual-channel DMA transfers. The DMA channel(s) are software-selectable. Refer to page 2-5 for information on specifying the DMA channel(s).

Each DMA channel can transfer up to 65,536 samples before it has to be reprogrammed with a new memory address. When more than 65,536 samples are required by an application, the A/D FIFO automatically stores the samples while the DMA channel is being reprogrammed for another address. In most situations, the A/D FIFO allows you to acquire large amounts of gap-free data into multiple buffers at up to maximum board speed using a single DMA channel. However, if possible, you should use dual-channel DMA to acquire data reliably at maximum board speeds.

Analog Output Features

The following boards contain analog output circuitry:

- DAS-1701ST-DA and DAS-1702ST-DA
- DAS-1702HR-DA
- DAS-1701AO and DAS-1702AO

The analog output features of these board are described in the following sections.

DAS-1701ST-DA and DAS-1702ST-DA Boards

DAS-1701ST-DA and DAS-1702ST-DA boards contain four 12-bit digital-to-analog converters (DACs). Each DAC has a fixed voltage range of ±10 V and powers up to 0 V at reset. Data coding is twos complement. The four DACs have a capacitive load drive up to 100 µF and an output current drive of up to ±5 mA.

You can use the internal A/D pacer clock to pace the analog output operation if no analog input operation is in progress or if the analog input operation is paced by an external pacer clock.

Note: You cannot use the DMA resources of DAS-1701ST-DA and DAS-1702ST-DA boards to perform an analog output operation. In addition, you cannot use an external trigger or an external pacer clock to perform an analog output operation.

DAS-1702HR-DA Boards

DAS-1702HR-DA boards contain two 16-bit DACs. Each DAC has a fixed voltage range of ±10 V and powers up to 0 V at reset. Data coding is twos complement. The two DACs have a capacitive load drive up to 100 µF and an output current drive of up to ±5 mA (short-circuit current is about 25 mA).

You can use the internal A/D pacer clock to pace the analog output operation if no analog input operation is in progress or if the analog input operation is paced by an external pacer clock.

Note: You cannot use the DMA resources of DAS-1702HR-DA boards to perform an analog output operation. In addition, you cannot use an external trigger or an external pacer clock to perform an analog output operation.

DAS-1701AO and DAS-1702AO Boards

DAS-1701AO and DAS-1702AO boards contain two 12-bit DACs with bipolar outputs. Each DAC is deglitched (a glitch is a transient that can occur during certain types of voltage changes). The DACs power up to 0 V at reset.

The analog output features of DAS-1701AO and DAS-1702AO boards are described in the following sections.

Output Ranges

Each DAC can have a bipolar output range of ±5 V or ±10 V. The range is software-selectable.

Pacer Clock

The pacer clock determines the rate at which the board writes new values from the D/A FIFO to the DACs. Through software, you select either the internal D/A pacer clock or an external pacer clock. You can also use the internal A/D pacer clock or the burst mode conversion clock to synchronize D/A conversions with A/D conversions. The pacer clocks are described in the following sections.

Note: The rate at which the board can reliably write new values to the DACs depends on a number of factors, including your computer, the operating system/environment, the settling time of the DACs, the way data is transferred to the board, and software issues.

Internal D/A Pacer Clock

The internal D/A pacer clock consists of a 16-bit counter with an optional divide-by-ten prescaler driven by a 5 MHz crystal oscillator. The maximum available rate is 200 ksamples/s; the minimum available rate is 7.63 samples/s.

External Pacer Clock

The external pacer clock is an externally applied TTL-compatible signal attached to the XPCLK pin (pin 44 of the board's main I/O connector or pin 38 of STA-1800U connectors J1 and J2). Note that an external pacer clock for an analog input operation also uses the XPCLK pin. The active edge of the external pacer clock is software-selectable.

An external clock is useful if you want to pace at rates not available with the internal D/A pacer clock, if you want to pace at uneven intervals, or if you want to pace on the basis of an external event. By attaching the same external pacer clock to the XPCLK pins of multiple boards, you can synchronize all the boards to the external pacer clock.

Clock Used for an Analog Input Operation

If you are using one of the onboard clocks (either the internal A/D pacer clock or the burst mode conversion clock) to pace an analog input operation, you can use the clock that paces the analog input operation to also determine the update rate for an analog output operation. Using the same clock to pace both D/A and A/D conversions allows you to perform tightly coupled stimulus-response operations at rates of up to 166.67 ksamples/s.

Note: You cannot synchronize an analog output operation to an analog input operation that is being paced by an external pacer clock.

Triggers

A trigger is an event that occurs based on a specified set of conditions. The trigger event determines when updates of the analog output channels begin and can be a software trigger or an external digital trigger, as described in the following sections.

Note: DAS-1701AO and DAS-1702AO boards do not provide a hardware-based analog trigger. However, you can program an analog start trigger through software, using one of the analog input channels as the trigger channel. The DAS-1700 Series Function Call Driver provides functions for an analog trigger; refer to the *DAS-1700 Series Function Call Driver User's Guide* for more information.

Software Trigger

A software trigger event occurs when you start the analog output operation (the computer issues a write to allow conversions). The point at which conversions begin depends on the pacer clock; refer to page 7-25 for more information. Note that the delay between the point at which you start the analog output operation and the point at which the internal D/A pacer clock starts is about 1 µs.

External Digital Trigger

An external digital trigger event occurs when the DAS-1701AO or DAS-1702AO board detects either a negative edge or a positive edge at the TGIN pin (pin 46 of the board's main I/O connector or pin 42 of STA-1800U connectors J1 and J2). Note that an external digital trigger for an analog input operation also uses the TGIN pin. The trigger signal is TTL-compatible and the polarity (active edge) is software-selectable.

Conversions begin about 400 ns after the active edge of the external digital trigger if you are using the internal D/A pacer clock or on the next active edge of an external pacer clock. Refer to page 7-25 for more information about pacer clocks.

If you are using an external digital trigger and you are using the D/A FIFO to transfer data from the computer to the board (no more than 2048 values), you can use retrigger mode to start generating the waveform stored in the D/A FIFO from the beginning each time the external digital trigger event occurs. This allows you to synchronize the generation of a waveform to an external digital trigger event.

Hardware Gate

A hardware gate is an externally applied digital signal that determines whether conversions occur. You connect the gate signal to the TGIN pin (pin 46 of the board's main I/O connector or pin 42 of STA-1800U connectors J1 and J2).

If you specify a positive gate, conversions occur only if the signal to TGIN is high; if the signal to TGIN is low, conversions are inhibited. If you specify a negative gate, conversions occur only if the signal to TGIN is low; if the signal to TGIN is high, conversions are inhibited. Note that the hardware gate for an analog input operation also uses the TGIN pin. The gate signal is TTL-compatible and the polarity of the hardware gate is software-selectable.

When using the internal D/A pacer clock, D/A conversions begin about 400 ns after the gate signal becomes active and terminate when the gate signal becomes inactive. When using an external pacer clock, D/A conversions begin on the next active clock edge after the gate signal becomes active and terminate when the gate signal becomes inactive.

DAS-1701AO and DAS-1702AO boards contain a 2048-word D/A FIFO to store analog output values. You can transfer data from computer memory to the D/A FIFO using either interrupts or the DMA resources of the board. The analog output values are then written to the DACs, at a rate determined by the pacer clock.

If the output waveform you want to generate from a DAC is repetitive and contains 2048 values or fewer, you can use recycle mode to continuously generate the waveform.

The following sections contain more information on using interrupts, using the DMA resources of the board, and using recycle mode.

Using Interrupts

You can program the board to generate an interrupt if the D/A FIFO is no longer full of data (FIFO Not Full) or if the FIFO contains fewer than 1025 values (FIFO Not Half Full). An interrupt service routine can then transfer data from computer memory to the D/A FIFO while the FIFO continues to write values to the DACs. Refer to page 7-33 for more information about interrupts.

The interrupt level (3, 5, 7, 10, 11, or 15) is software-selectable. Refer to page 2-5 for information on specifying the interrupt level.

Using DMA Resources

You can use the DMA controller to bypass the CPU and transfer data directly from computer memory to the D/A FIFO.

DAS-1700 Series boards use DMA channel 5, 6, or 7 to perform single-channel DMA transfers. The DMA channel is software-selectable. Refer to page 2-5 for information on specifying the DMA channel. (Note that you cannot to perform dual-channel DMA transfers for analog output operations.)

Using Recycle Mode

If you use a waveform of between 2 and 2048 values (all the values fit in the D/A FIFO), you can use recycle mode to continuously generate the waveform. The analog output values are transferred to the D/A FIFO once (using either interrupts or the DMA resources of the board) and then are continuously written to the DACs directly from the D/A FIFO. Recycle mode is the fastest way to transfer data because it does not require the use of the computer bus.

Digital I/O Features

DAS-1700 Series boards contain four digital input lines (DI0 to DI3) and four digital output lines (DO0 to DO3). Logic 1 on a digital I/O line indicates that the input/output is high (greater than 2.0 V); logic 0 on a digital I/O line indicates that the input/output is low (less than 0.8 V).

The digital input signals are TTL-compatible. The input signals are provided with 10 kΩ pull-up resistors to +5 V; therefore, the inputs appear high (logic 1) with no signal connected. DAS-1700 Series boards provide a latch strobe for digital output signals; refer to page 7-30 for information.

You can use the internal A/D pacer clock to pace the digital I/O operation if no analog input operation is in progress or if the analog input operation is paced by an external pacer clock.

Note: You cannot use the DMA resources of DAS-1700 Series boards to perform a digital I/O operation. In addition, you cannot use an external trigger or an external pacer clock to perform a digital I/O operation.

Digital Control Signals

The following sections describe the digital control signals provided on DAS-1700 Series boards.

Strobe Signal

DAS-1700 Series boards provide a strobe signal DOSTB (pin 19 of the board's main I/O connector or pin 37 of STA-1800U connectors J1 and J2) for the purpose of strobing data through the digital output lines and latching the data into a register in external equipment. DAS-1700 Series boards use the positive edge of the strobe to strobe data out; however, you must use the negative edge to strobe data into other equipment because the negative edge provides a 300 ns lag to allow for delays. Data is valid until the next strobe, as shown in Figure 7-8.

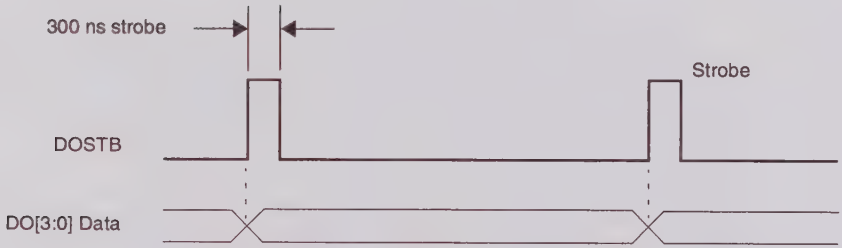


Figure 7-8. Timing Relationship between Data from DO0 to DO3 and Latch Strobe DOSTB

Trigger/Gate Output Signal

If you are using the internal A/D pacer clock to pace an analog input operation, you can use the trigger/gate output signal TGOUT (pin 20 of the board's main I/O connector or pin 39 of STA-1800U connectors J1 and J2) to synchronize the start of analog input operations on other DAS-1700 Series boards or to act as a trigger or gate for user-defined events, as follows:

- When using the TGIN pin as an external digital trigger, TGOUT behaves as shown in Figure 7-9a. Note that TGOUT does not retrigger and cannot be used with about-trigger acquisitions. Note also that a delay of about 200 ns occurs between the active edge of TGIN and the starting edge of TGOUT.

- When using the TGIN pin as a hardware gate, TGOUT behaves as shown in Figure 7-9b. Note that a delay of about 200 ns occurs between the active edge of TGIN and the starting edge of TGOUT.
- When using a software trigger or when the hardware gate is disabled (TGIN pin is not used), TGOUT behaves as shown in Figure 7-9c. Note that the delay between the point at which software enables conversions and the starting edge of TGOUT is less than 1 µs.

Note: You cannot use TGOUT when an external pacer clock is pacing the analog input operation.

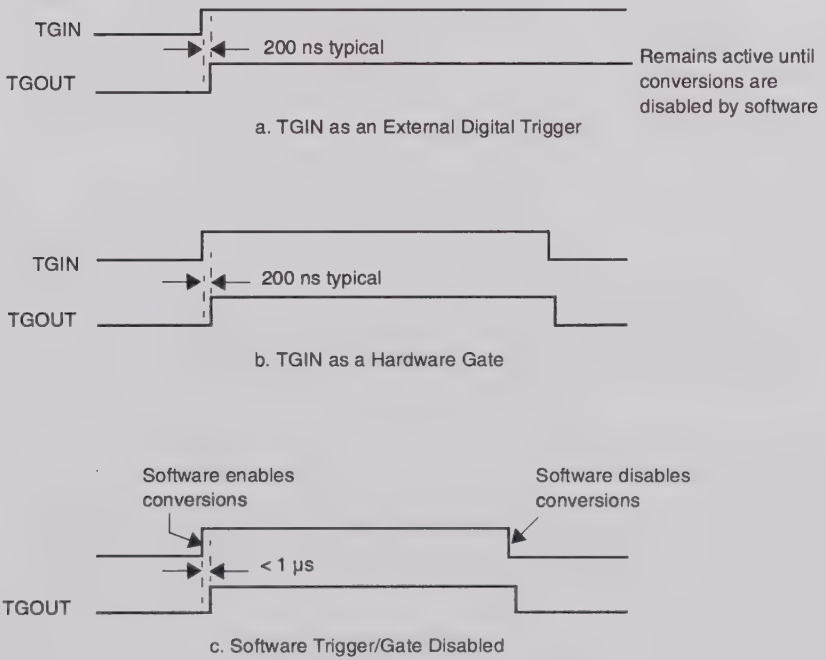


Figure 7-9. Timing for the TGOUT Signal

SSH Output Signal

The SSH output signal SSHO (pin 45 of the board's main I/O connector or pin 40 of STA-1800U connectors J1 and J2) is normally generated by DAS-1700ST Series and DAS-1700AO Series boards to accommodate external SSH hardware. The SSHO signal is initiated by either the internal A/D pacer clock or an external pacer clock. Characteristics of the SSHO signal when used for SSH hardware control are as follows:

- SSHO is normally low, signifying that the SSH hardware is in sample mode.
- SSHO goes high (into the hold mode) about 50 ns after a pacer clock pulse.
- A/D conversion begins one burst period after the pacer clock pulse.
- SSHO remains high until 200 ns after the ADC starts conversion of the last channel in the burst.
- SSHO goes low and remains low until another pacer clock pulse.

To ensure adequate sample time for the SSH hardware, the pacer clock period should be set as follows:

$$\text{Pacer Clock Period} \geq (\text{Number of Channels} + 1) \times (\text{Burst Period})$$

When you are not using the SSHO signal for SSH hardware control, you can use it as a converter clock output signal. SSHO is active only during A/D conversions. Figure 7-10 shows the timing for SSHO generation when DAS-1700 Series boards are not used for control of SSH hardware.

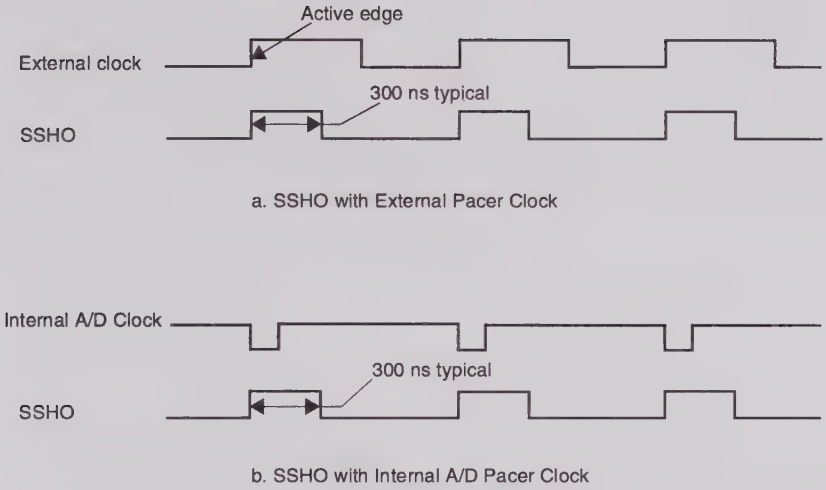


Figure 7-10. Timing for SSHO Signal When Not Used for SSH Hardware

Interrupts

You assign an interrupt level to a DAS-1700 Series board using the configuration file; refer to page 2-5. When you install more than one board in a computer, you can assign a different interrupt level to each board (if enough levels are available), or you can assign the same interrupt level to some or all boards.

If a DAS-1700 Series board is sharing an interrupt level with one or more other DAS-1700 Series boards and requests an interrupt, the software determines the source of the request by scanning each board until the interrupt request flag is located. The software then signals the computer to respond accordingly.

Power

DAS-1700 Series boards use the +5 V and the +12 V provided by your computer. An onboard DC/DC converter develops ±15 V at a maximum current output of 60 mA for external use. In addition to the ±15 V, DAS-1700 Series boards supply +5 V from the computer to the +5 V pins (pins 24 and 49 of the board's main I/O connector or pins 47 and 48 of STA-1800U connectors J1 and J2) at a maximum of 1.0 A.

A

Specifications

This appendix contains the specifications for DAS-1700 Series boards, as follows:

Board	Features	Table
DAS-1701ST DAS-1702ST	Analog input	Table A-1 on page A-2
	Digital I/O	Table A-7 on page A-14
	Power supply	Table A-8 on page A-14
DAS-1702HR	Analog input	Table A-2 on page A-5
	Digital I/O	Table A-7 on page A-14
	Power supply	Table A-8 on page A-14
DAS-1701ST-DA DAS-1702ST-DA	Analog input	Table A-1 on page A-2
	Analog output	Table A-4 on page A-11
	Digital I/O	Table A-7 on page A-14
	Power supply	Table A-9 on page A-15
DAS-1702HR-DA	Analog input	Table A-2 on page A-5
	Analog output	Table A-5 on page A-12
	Digital I/O	Table A-7 on page A-14
	Power supply	Table A-9 on page A-15
DAS-1701AO DAS-1702AO	Analog input	Table A-3 on page A-8
	Analog output	Table A-6 on page A-12
	Digital I/O	Table A-7 on page A-14
	Power supply	Table A-10 on page A-15

Table A-1. DAS-1700ST Series - Analog Input Specifications

Feature	DAS-1701ST/ST-DA	DAS-1702ST/ST-DA
Number of channels	Software-selectable as 8 differential or 16 single-ended	
Input range type	Software-selectable as unipolar or bipolar	
Resolution	12-bit (1 part in 4096 or 244 ppm)	
Data format	12-bit twos complement	
A/D FIFO size	1024 word	
Channel-gain queue size	256 locations	
Channel-gain queue	Channels: 256 X 8 bits (256 channels maximum) Gains: 256 X 2 bits (four gain ranges)	
Range/gain	Unipolar • 0 to +5 V for gain = 1 • 0 to +1 V for gain = 5 • 0 to +100 mV for gain = 50 • 0 to +20 mV for gain = 250 Bipolar • ±5 V for gain = 1 • ±1 V for gain = 5 • ±100 mV for gain = 50 • ±20 mV for gain = 250	Unipolar • 0 to +10 V for gain = 1 • 0 to +5 V for gain = 2 • 0 to +2.5 V for gain = 4 • 0 to 1.25 V for gain = 8 Bipolar • ±10 V for gain = 1 • ±5 V for gain = 2 • ±2.5 V for gain = 4 • ±1.25 V for gain = 8
Absolute accuracy	Typical 0.01% of reading ±1 LSB for all ranges Maximum @ 25°C • 0.02% of reading ±1 LSB for gain < 250 • 0.03% of reading ±1 LSB for gain = 250	
Temperature coefficient of accuracy (includes ADC)	Offset • ±20 µV/°C ±(12 µV/°C ÷ gain) maximum for bipolar • ±20 µV/°C ±(14 µV/°C ÷ gain) maximum for unipolar Gain • ±20 ppm/°C for gain < 50 • ±30 ppm/°C for gain = 50 • ±35 ppm/°C for gain = 250	
Linearity[1]	• Integral: ±½ LSB typical, ±1 LSB maximum • Differential: ±1 LSB	
Throughput	166.67 ksamples/s, maximum	

Table A-1. DAS-1700ST Series - Analog Input Specifications (cont.)

Feature	DAS-1701ST/ST-DA	DAS-1702ST/ST-DA
Dynamic parameters	• Acquisition time: 0.3 µs • Aperture delay: 13.0 ns • Aperture uncertainty: 150 ps rms • Conversion time: 3.0 µs maximum (includes acquisition time)	
Input bias current	• ±40 nA maximum @ 25°C • ±60 nA maximum over operating range	
Common-mode rejection ratio	• 74 dB for gain = 1 • 80 dB for gain = 5 • 100 dB for gain = 50 • 100 dB for gain = 250	• 74 dB for gain = 1 • 80 dB for gain = 2 • 80 dB for gain = 4 • 86 dB for gain = 8
Input overvoltage	• ±15 V continuous, powered and unpowered	
Noise[2] (in counts)	Bipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 5 • p-p = 4, rms = 0.5 for gain = 50 • p-p = 8, rms = 1.0 for gain = 250 Unipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 5 • p-p = 6, rms = 0.9for gain = 50 • p-p = 9, rms = 1.4 for gain = 250	Bipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 2 • p-p = 1, rms = 0.1 for gain = 4 • p-p = 1, rms = 0.1 for gain = 8 Unipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 2 • p-p = 1, rms = 0.1 for gain = 4 • p-p = 1, rms = 0.1 for gain = 8
DMA	• Burst demand mode DMA on FIFO NOT EMPTY • Programmable DMA channels (5, 6, and 7) • Single/dual DMA modes	
Interrupts	• On FIFO not empty (single/slow transfer) • On FIFO half full (REP MOV) • On Counter 2 terminal count • On data overflow • Programmable interrupt levels (3, 5, 7, 10, 11, and 15) • Shareable pulsed interrupts	
Burst-mode acquisition	Rate: programmable from 16 ksamples/s to 166.67 ksamples/s Length: programmable from 1 to 256 conversions per trigger Other: direct simultaneous sample-and-hold support	
Minimum external pacer clock pulse width	10 ns	

Table A-1. DAS-1700ST Series - Analog Input Specifications (cont.)

Feature	DAS-1701ST/ST-DA	DAS-1702ST/ST-DA
Maximum external pacer clock rate	166.67 ksamples/s	
Minimum hardware trigger pulse width	10 ns	
Trigger	Sources • Internal A/D pacer clock, gate disabled • Internal A/D pacer clock, ext. digital trigger (programmable edge) • Internal A/D pacer clock, hardware gate (programmable level) • External pacer clock, gate disabled • External pacer clock, external digital trigger (programmable edge) • External pacer clock, hardware gate (programmable level) Types • Post-trigger • Pre-trigger • About-trigger (using counter 0)	
Pacer clock	Internal A/D: 32-bit counter (82C54) External: programmable edge (±)	

Notes

[1] Monotonicity is guaranteed over the operating range.

[2] Includes the electrical noise introduced by the analog front end but does not include the uncertainty inherent in the quantization process. The inherent quantization noise introduced by any ADC is due to uncertainty at code boundaries and adds a peak-to-peak value of 1 LSB to the electrical noise; it also makes the rms level 0.5 LSB.

Table A-2. DAS-1700HR Series - Analog Input Specifications

Feature	DAS-1702HR/HR-DA
Number of channels	Software-selectable as 8 differential or 16 single-ended
Input range type	Software-selectable as unipolar or bipolar
Resolution	16-bits (1 part in 65,536 or 15 ppm)
Data format	16-bit twos complement
A/D FIFO size	1024 word
Channel-gain queue	Channels: 256 X 8 bits (256 channels maximum) Gains: 256 X 2 bits (four gain ranges)
Range/gain	Unipolar • 0 to +10 V for gain = 1 • 0 to +5 V for gain = 2 • 0 to +2.5 V for gain = 4 • 0 to 1.25 V for gain = 8 Bipolar • ±10 V for gain = 1 • ±5 V for gain = 2 • ±2.5 V for gain = 4 • ±1.25 V for gain = 8
Absolute accuracy	Typical 0.005% of reading ±1 LSB for all ranges Maximum • 0.005% of reading ±1.5 LSB for gain = 1 • 0.01% of reading ±1.5 LSB for gain ≠ 1
Relative accuracy	Typical: 0.001% of reading ±1 LSB Maximum: 0.001% of reading ±1.5 LSB maximum range of 0 to 70°C
Temperature coefficient of accuracy (includes ADC)	Offset • ±5 µV/°C maximum for bipolar • ±5 µV/°C maximum for unipolar Gain • ±7.5 ppm/°C
Linearity[1]	Integral: ±1.5 LSB maximum Differential: ±1 LSB
Throughput	50 ksamples/s, maximum

Table A-2. DAS-1700HR Series - Analog Input Specifications (cont.)

Feature	DAS-1702HR/HR-DA
Dynamic parameters	• Acquisition time: 2 µs • Aperture delay: 6.0 ns • Aperture uncertainty: - 100 ps rms when used with internal A/D pacer clock - 200 ns maximum with external pacer clock • Conversion time: 8.0 µs maximum
Input bias current	• ±2 nA maximum @ 25°C • ±100 nA maximum over operating range
Input impedance	100 MΩ in parallel with 75 pF
Common-mode rejection ratio	• 100 dB for gain = 1 • 100 dB for gain = 2 • 100 dB for gain = 4 • 100 dB for gain = 8
Input overvoltage	• ±15.0 V continuous powered and unpowered
Noise[2] (in counts)	Bipolar electrical noise • p-p = ±2.0, rms = 0.5 for gain = 1 • p-p = ±2.0, rms = 0.5 for gain = 2 • p-p = ±2.5, rms = 0.6 for gain = 4 • p-p = ±2.5, rms = 0.7 for gain = 8 Unipolar electrical noise • p-p = ±2.0, rms = 0.6 for gain = 1 • p-p = ±2.0, rms = 0.6 for gain = 2 • p-p = ±2.5, rms = 0.7 for gain = 4 • p-p = ±3.0, rms = 0.8 for gain = 8
DMA	• Burst demand mode DMA on FIFO NOT EMPTY • Programmable DMA channels (5, 6, and 7) • Single/dual DMA modes
Interrupts	• On FIFO not empty (single/slow transfer) • On FIFO half full (REP MOV) • On Counter 2 terminal count • On data overflow • Programmable interrupt levels (3, 5, 7, 10, 11, and 15) • Shareable pulsed interrupts
Burst-mode acquisition	Rate: programmable from 16 ksamples/s to 50 ksamples/s Length: programmable from 1 to 256 conversions per trigger

Table A-2. DAS-1700HR Series - Analog Input Specifications (cont.)

Feature	DAS-1702HR/HR-DA
Minimum external pacer clock pulse width	10 ns
Maximum external pacer clock rate	50 ksamples/s
Minimum hardware trigger pulse width	10 ns
Trigger	Sources • Internal A/D pacer clock, gate disabled • Internal A/D pacer clock, ext. digital trigger (programmable edge) • Internal A/D pacer clock, hardware gate (programmable level) • External pacer clock, gate disabled • External pacer clock, external digital trigger (programmable edge) • External pacer clock, hardware gate (programmable level) Types • Post-trigger • Pre-trigger • About-trigger (using counter 0)
Pacer clock	Internal A/D: 32-bit counter (82C54) External: programmable edge (±)

Notes

[1] Monotonicity is guaranteed to 16 bits.

[2] Includes the electrical noise introduced by the analog front end and includes the quantization noise.

Table A-3. DAS-1700AO Series - Analog Input Specifications

Feature	DAS-1701AO	DAS-1702AO
Number of channels	Software-selectable as 8 differential or 16 single-ended	
Input range type	Software-selectable as unipolar or bipolar	
Resolution	12-bit (1 part in 4096)	
Data format	12-bit twos complement	
A/D FIFO size	1024 word	
Channel-gain queue	Channels: 256 x 8 bits (256 channels maximum) Gains: 256 x 3 bits (four gain ranges; two external)	
Range/gain	Unipolar • 0 to +5 V for gain = 1 • 0 to +1 V for gain = 5 • 0 to +100 mV for gain = 50 • 0 to +20 mV for gain = 250 Bipolar • ±5 V for gain = 1 • ±1 V for gain = 5 • ±100 mV for gain = 50 • ±20 mV for gain = 250	Unipolar • 0 to +10 V for gain = 1 • 0 to +5 V for gain = 2 • 0 to +2.5 V for gain = 4 • 0 to 1.25 V for gain = 8 Bipolar • ±10 V for gain = 1 • ±5 V for gain = 2 • ±2.5 V for gain = 4 • ±1.25 V for gain = 8
Absolute accuracy	Typical 0.01% of reading ±1 LSB for all ranges Maximum @ 25°C • 0.02% of reading ±1 LSB for gain < 250 • 0.03% of reading ±1 LSB for gain = 250	
Temperature coefficient of accuracy (includes ADC)	Offset • ±20 µV/°C ±(12 µV/°C ÷ gain) maximum for bipolar • ±20 µV/°C ±(14 µV/°C ÷ gain) maximum for unipolar Gain • ±20 ppm/°C for gain < 50 • ±30 ppm/°C for gain = 50 • ±35 ppm/°C for gain = 250	
Linearity[1]	• Integral: ±½ LSB typical, ±1 LSB maximum • Differential: ±1 LSB	
Throughput	166.67 ksamples/s, maximum	

Table A-3. DAS-1700AO Series - Analog Input Specifications (cont.)

Feature	DAS-1701AO	DAS-1702AO
Dynamic parameters	• Acquisition time: 0.3 µs • Aperture delay: 13.0 ns • Aperture uncertainty: 150 ps rms • Conversion time: 3.0 µs maximum (includes acquisition time)	
Input bias current	• ±40 nA maximum @ 25°C • ±60 nA maximum over operating range	
Common-mode rejection ratio	• 74 dB for gain = 1 • 80 dB for gain = 5 • 100 dB for gain = 50 • 100 dB for gain = 250	• 74 dB for gain = 1 • 80 dB for gain = 2 • 80 dB for gain = 4 • 86 dB for gain = 8
Input overvoltage	• ±15 V continuous, powered and unpowered	
Noise[2] (in counts)	Bipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 5 • p-p = 2, rms = 0.2 for gain = 50 • p-p = 3, rms = 0.5 for gain = 250 Unipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 5 • p-p = 3, rms = 0.4 for gain = 50 • p-p = 5, rms = 0.9 for gain = 250	Bipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 2 • p-p = 1, rms = 0.1 for gain = 4 • p-p = 1, rms = 0.1 for gain = 8 Unipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 2 • p-p = 1, rms = 0.1 for gain = 4 • p-p = 1, rms = 0.1 for gain = 8
DMA	• Burst demand mode DMA • Request on FIFO Not Empty • Programmable DMA channels (5, 6, and 7) • Single/dual DMA modes	
Interrupts	• On FIFO not empty • On FIFO half full • On A/D Counter 0 terminal count • On data overflow • Programmable interrupt levels (3, 5, 7, 10, 11, and 15)	
Burst-mode acquisition	• Rate: programmable 16 ksamples/s to 166.67 ksamples/s • Length: programmable 1 to 256 conversions • Other: simultaneous sample-and-hold support	
Minimum external pacer clock pulse width	10 ns	
Maximum external pacer clock rate	166.67 ksamples/s	

Table A-3. DAS-1700AO Series - Analog Input Specifications (cont.)

Feature	DAS-1701AO	DAS-1702AO
Minimum hardware trigger pulse width	10 ns	
Trigger	Sources • Internal A/D pacer clock, gate disabled • Internal A/D pacer clock, ext. digital trigger (programmable edge) • Internal A/D pacer clock, hardware gate (programmable level) • External pacer clock, gate disabled • External pacer clock, external digital trigger (programmable edge) • External pacer clock, hardware gate (programmable level) Types • Pre-trigger • About-trigger (using A/D counter 0) • Post-trigger	
Pacer clock	• Internal A/D: 32-bit counter (82C54) • External: programmable edge (±)	

Notes

[1] Monotonicity is guaranteed over the operating range.

[2] Includes the electrical noise introduced by the analog front end but does not include the uncertainty inherent in the quantization process. The inherent quantization noise introduced by any ADC is due to uncertainty at code boundaries and adds a peak-to-peak value of 1 LSB to the electrical noise; it also makes the rms level 0.5 LSB.

Table A-4. DAS-1701ST-DA and DAS-1702ST-DA - Analog Output Specifications

Attribute	Specification
Resolution	12-bit (one part in 4096 or 224 ppm)
Coding	12-bit twos complement, right justified
Output range	−10.000 V to +9.9951 V
Integral nonlinearity	±¼ LSB typical, ±½ LSB maximum
Differential nonlinearity	± ½ LSB typical, ±1 LSB maximum
Monotonicity	12 bits guaranteed
Settling time	6 µs typical, 30 µs maximum to ½ LSB
Output current drive	±15 mA maximum
Gain accuracy	Adjustable to 0
Offset accuracy	Adjustable to 0
Temperature drift	Offset: ±15 ppm/°C maximum Gain: ±30 ppm/°C maximum
Glitch energy	200 nV * seconds typical area; 200 mV peak
Capacitive load drive	100 µF
Power-up	DACs power up to 0.0 V at reset

Table A-5. DAS-1702HR-DA - Analog Output Specifications

Attribute	Specification
Type	16-bit, voltage out DAC
Coding	16-bit twos complement (signed 16-bit integer)
Output range	–10.0000 V to +9.999695 V
Integral nonlinearity	±1 LSB typical, ±2 LSB maximum
Differential nonlinearity	±1 LSB typical, ±2 LSB maximum
Monotonicity	16 bits typical, 15 bits worst-case
Absolute accuracy	±2 LSB @ 25°C
Temperature drift	Offset: ±5 ppm/°C maximum Gain: ±5 ppm/°C maximum
Glitch energy	Area: 15 nV * seconds Peak: 15 mV
Capacitive load drive	100 µF
Settling time	100 µs to ±1 LSB of final value (less than 100 pF load)
Output current drive	±5 mA (25 mA short-circuit current)
Power-up	DACs power up to 0.0 V at reset

Table A-6. DAS-1700AO Series - Analog Output Specifications

Feature	Specification
Channels	2, deglitched
Range	±5 V, ±10 V (software selectable for each DAC)
Resolution	12-bit (1 part in 4096 or 244 ppm)
Current output	±15 mA maximum
Output impedance	4 Ω (maximum @ 300 kHz)
Capacitive drive	100 µF maximum
Glitch energy	Zero glitch feedthrough
Hold error	1.5 nV * s, typical (i.e. 1 mV * 1.5 µs); 7.5 nV * s, maximum

Table A-6. DAS-1700AO Series - Analog Output Specifications (cont.)

Feature	Specification
Gain accuracy	Adjustable to 0
Offset accuracy	Adjustable to 0
Linearity	• Integral: ±0.25 LSB typical; ±0.75 LSB maximum • Differential: ±0.75 LSB maximum • Monotonicity: guaranteed over operating range
Settling time	• 3 µs for 20 V step, typical • 1.8 µs for LSB of major carry, typical
Slew rate	10 V/µs minimum
Throughput	200 ksamples/s, maximum
Output at reset or power-up	0 V
Data transfer size	16 bits (AT bus)
D/A FIFO	2048 word
Format	12-bit, twos complement, right-justified
DMA	• Burst demand mode DMA • Programmable DMA levels (levels 5, 6, and 7) • Request on FIFO Not Full
Interrupt	• On FIFO not full • On FIFO not half full • On data underflow • On DMA terminal count • Uses selected A/D interrupt level
Trigger sources	• Internal D/A pacer clock, gate disabled • Internal D/A pacer clock, ext. digital trigger (programmable edge) • Internal D/A pacer clock, hardware gate (programmable level) • External pacer clock, gate disabled • External pacer clock, external digital trigger (programmable edge) • External pacer clock, hardware gate (programmable level)
Pacer clock	• Internal D/A: 16-bit counter using 5 MHz clock (with selectable divide-by-10 prescaler) • External: programmable edge • Pacer clock used for analog input operation

Table A-7. DAS-1700 Series - Digital I/O Specifications

Attributes	Specification
Digital output signals	DOSTB, SSHO, and TGOUT • V_{OH} (min.) = 2.4 V @ I_{OH} = -3 mA • V_{OL} (max.) = 0.5 V @ I_{OL} = 24 mA DO 0 to DO 3, GEXT, and MUX 3 to MUX 7 • V_{OH} (min.) = 2.7 V @ I_{OH} = –400 µA • V_{OL} (max.) = 0.5 V @ I_{OL} = 8 mA
Digital input signals	DI 0 to DI 3, XPCLK and TGIN[1] • V_{IH} (min.) = 2.0 V; I_{IH} (max.) = 20 µA • V_{IL} (max.) = 0.8 V; I_{IL} (max.) = –0.2 mA
Digital output strobe pulse width	300 ns typical; data is latched on the rising edge of DOSTB

Notes

[1] Digital inputs DI 0 to DI 3 are pulled up with a 10 kΩ resistor. On DAS-1701ST, DAS-1702ST, DAS-1702HR, DAS-1701AO, and DAS-1702AO boards, inputs TGIN and XPCLK are not pulled up; on DAS-1701ST-DA, DAS-1702ST-DA, and DAS-1702HR-DA boards, inputs TGIN and XPCLK are pulled up with 10 kΩ resistors.

Table A-8. DAS-1701ST, DAS-1702ST, and DAS-1702HR - Power Supply Requirements

Attribute	DAS-1701ST/DAS-1702ST	DAS-1702HR
+5 VDC input	520 mA typical; 870 mA maximum	500 mA typical; 870 mA maximum
+12 VDC input	190 mA typical; 550 mA maximum	200 mA typical; 550 mA maximum
Maximum current available at the ±15 V outputs[1]	70 mA	70 mA
Maximum current available at the +5 V output	1.0 A	1.0 A

Notes

[1] Subtract the current output of the DACs from the value given here.

Table A-9. DAS-1701ST-DA, DAS-1702ST-DA, and DAS-1702HR-DA - Power Supply Requirements

Attribute	DAS-1701ST-DA/ DAS-1702ST-DA	DAS-1702HR-DA
+5 VDC input	483 mA typical; 768 mA maximum	610 mA typical; 850 mA maximum
+12 VDC input	378 mA typical; 700 mA maximum	350 mA typical; 550 mA maximum
Maximum current available at the ±15 V outputs[1]	70 mA	60 mA
Maximum current available at the +5 V output	1.0 A	1.0 A

Notes
[1] Subtract the current output of the DACs from the value given here.

Table A-10. DAS-1700AO Series - Power Supply Requirements

Attribute	Specification
+5 VDC input	510 mA typical; 835 mA maximum
+12 VDC input	455 mA typical; 690 mA maximum
Maximum current available at the ±15 V outputs	30 mA
Maximum current available at the +5 V output	1 A

B

Connector Pin Assignments

This appendix contains the following sections:

- **Main I/O Connector** - lists the pin assignments for the main I/O connector of a DAS-1700 Series board.
- **STA-1800U I/O Connectors J1 and J2** - lists the pin assignments for connectors J1 and J2 of a STA-1800U screw terminal accessory.
- **STA-1800U I/O Connectors J3** - lists the pin assignments for connector J3 of a STA-1800U screw terminal accessory.
- **STA-1800U I/O Connectors J4 to J7 and Jumper Pads J8 to J11** - lists the pin assignments for connectors J4 to J7 and jumper pads J8 to J11 of a STA-1800U screw terminal accessory.

Main I/O Connector

Pin assignments for the main I/O connector of a DAS-1700 Series board are shown in Figure B-1.

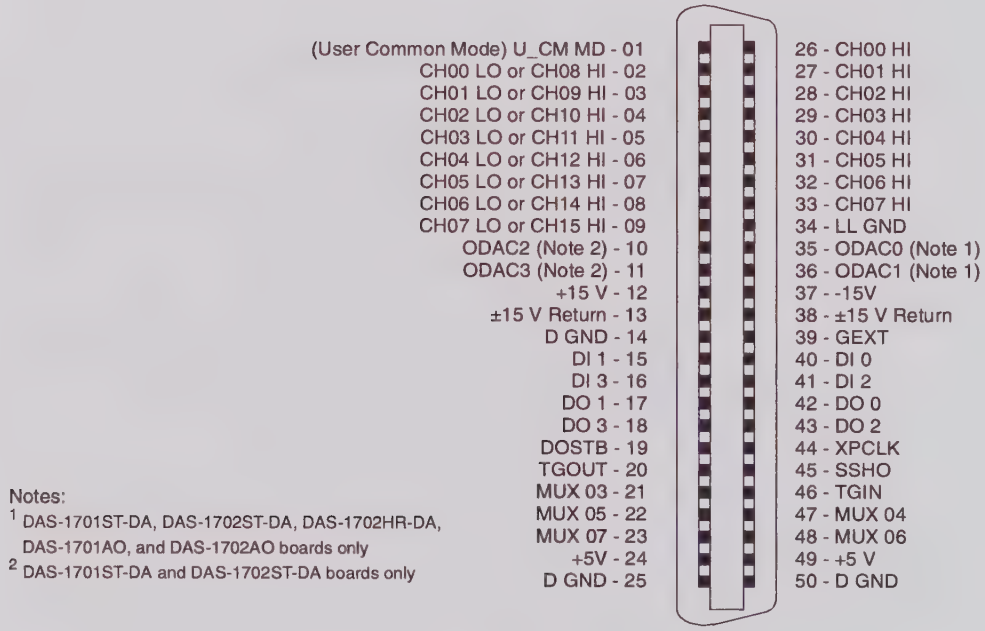

(User Common Mode) U_CM MD - 01
CH00 LO or CH08 HI - 02
CH01 LO or CH09 HI - 03
CH02 LO or CH10 HI - 04
CH03 LO or CH11 HI - 05
CH04 LO or CH12 HI - 06
CH05 LO or CH13 HI - 07
CH06 LO or CH14 HI - 08
CH07 LO or CH15 HI - 09
ODAC2 (Note 2) - 10
ODAC3 (Note 2) - 11
+15 V - 12
±15 V Return - 13
D GND - 14
DI 1 - 15
DI 3 - 16
DO 1 - 17
DO 3 - 18
DOSTB - 19
TGOUT - 20
MUX 03 - 21
MUX 05 - 22
MUX 07 - 23
+5V - 24
D GND - 25
26 - CH00 HI
27 - CH01 HI
28 - CH02 HI
29 - CH03 HI
30 - CH04 HI
31 - CH05 HI
32 - CH06 HI
33 - CH07 HI
34 - LL GND
35 - ODAC0 (Note 1)
36 - ODAC1 (Note 1)
37 - -15V
38 - ±15 V Return
39 - GEXT
40 - DI 0
41 - DI 2
42 - DO 0
43 - DO 2
44 - XPCLK
45 - SSHO
46 - TGIN
47 - MUX 04
48 - MUX 06
49 - +5 V
50 - D GND
Notes:
1 DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR-DA, DAS-1701AO, and DAS-1702AO boards only
2 DAS-1701ST-DA and DAS-1702ST-DA boards only

Figure B-1. Main I/O Connector

STA-1800U I/O Connectors J1 and J2

Pin assignments for I/O connectors J1 and J2 of the STA-1800U screw terminal accessory are shown in Figure B-2.

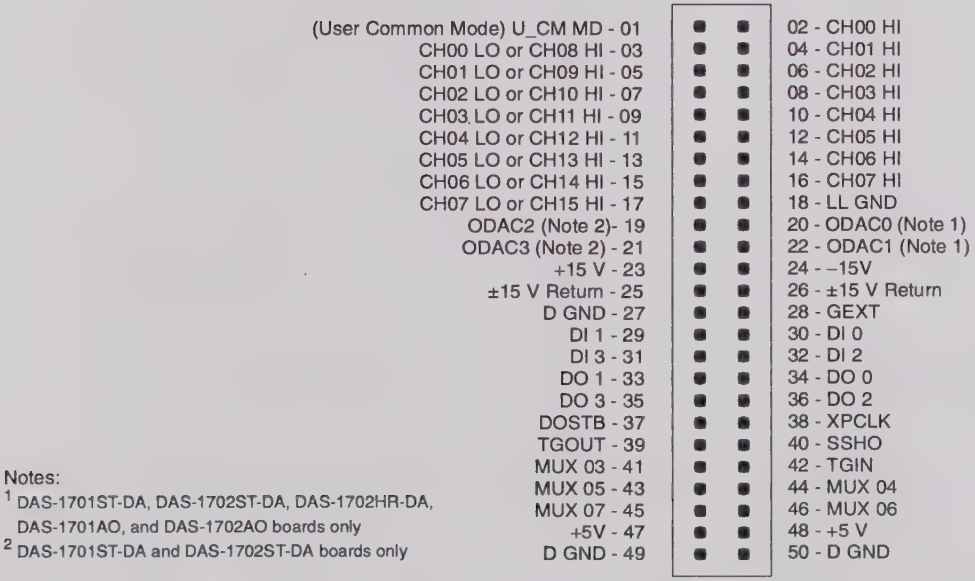

(User Common Mode) U_CM MD - 01
02 - CH00 HI
CH00 LO or CH08 HI - 03
04 - CH01 HI
CH01 LO or CH09 HI - 05
06 - CH02 HI
CH02 LO or CH10 HI - 07
08 - CH03 HI
CH03 LO or CH11 HI - 09
10 - CH04 HI
CH04 LO or CH12 HI - 11
12 - CH05 HI
CH05 LO or CH13 HI - 13
14 - CH06 HI
CH06 LO or CH14 HI - 15
16 - CH07 HI
CH07 LO or CH15 HI - 17
18 - LL GND
ODAC2 (Note 2)- 19
20 - ODAC0 (Note 1)
ODAC3 (Note 2) - 21
22 - ODAC1 (Note 1)
+15 V - 23
24 - –15V
±15 V Return - 25
26 - ±15 V Return
D GND - 27
28 - GEXT
DI 1 - 29
30 - DI 0
DI 3 - 31
32 - DI 2
DO 1 - 33
34 - DO 0
DO 3 - 35
36 - DO 2
DOSTB - 37
38 - XPCLK
TGOUT - 39
40 - SSHO
MUX 03 - 41
42 - TGIN
MUX 05 - 43
44 - MUX 04
MUX 07 - 45
46 - MUX 06
+5V - 47
48 - +5 V
D GND - 49
50 - D GND
Notes:
1 DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR-DA, DAS-1701AO, and DAS-1702AO boards only
2 DAS-1701ST-DA and DAS-1702ST-DA boards only

Figure B-2. STA-1800U I/O Connectors J1 and J2

STA-1800U I/O Connector J3

Pin assignments for I/O connector J3 of the STA-1800U screw terminal accessory are shown in Figure B-3.

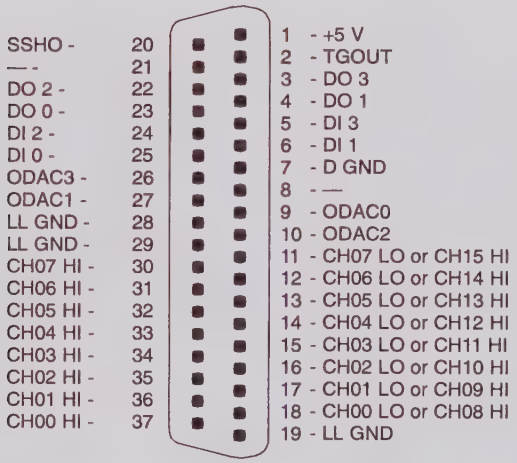

SSHO - 20
— - 21
DO 2 - 22
DO 0 - 23
DI 2 - 24
DI 0 - 25
ODAC3 - 26
ODAC1 - 27
LL GND - 28
LL GND - 29
CH07 HI - 30
CH06 HI - 31
CH05 HI - 32
CH04 HI - 33
CH03 HI - 34
CH02 HI - 35
CH01 HI - 36
CH00 HI - 37
1 - +5 V
2 - TGOUT
3 - DO 3
4 - DO 1
5 - DI 3
6 - DI 1
7 - D GND
8 - —
9 - ODAC0
10 - ODAC2
11 - CH07 LO or CH15 HI
12 - CH06 LO or CH14 HI
13 - CH05 LO or CH13 HI
14 - CH04 LO or CH12 HI
15 - CH03 LO or CH11 HI
16 - CH02 LO or CH10 HI
17 - CH01 LO or CH09 HI
18 - CH00 LO or CH08 HI
19 - LL GND

Figure B-3. STA-1800U I/O Connector J3

STA-1800U I/O Connectors J4 to J7 and Jumper Pads J8 to J11

Pin assignments for I/O connectors J4 to J7 and jumper pads J8 to J11 of the STA-1800U screw terminal accessory are shown in Figure B-4.

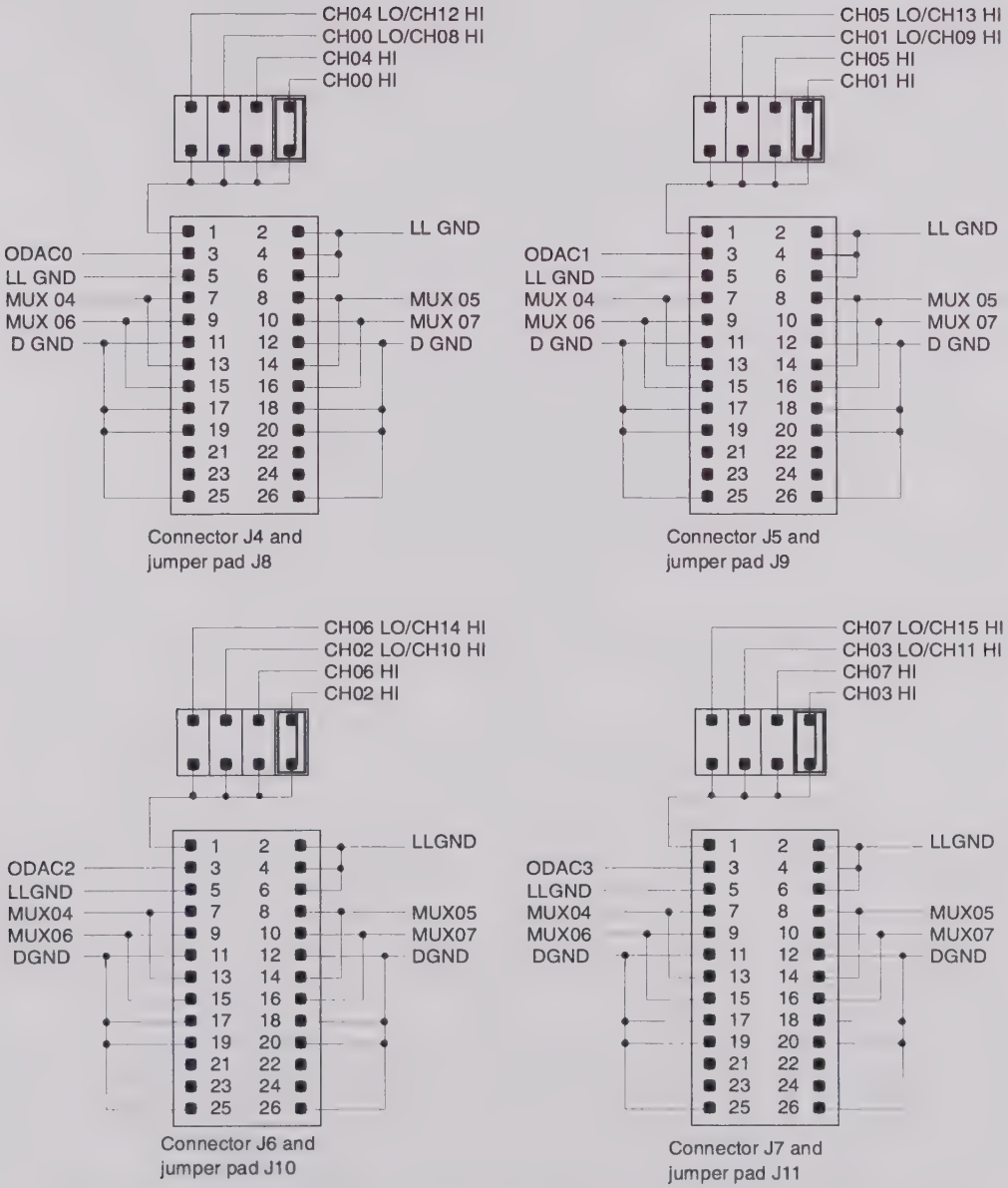


Figure B-4. STA-1800U I/O Connectors J4 to J7 and Jumper Pads J8 to J11

C

Keithley Memory Manager

This appendix contains the following sections:

- **Overview** - describes the Keithley Memory Manager.
- **Installing and Setting Up the KMM in Windows 3.1 and Windows for Workgroups 3.11** - describes how to install the Keithley Memory Manager in Windows 3.1 or Windows for Workgroups 3.11.
- **Installing and Setting Up the KMM in Windows 95** - describes how to install the Keithley Memory Manager in Windows 95.
- **Removing the KMM** - describes how to remove the Keithley Memory Manager and return all reserved memory to Windows.

Overview

The Keithley Memory Manager (KMM), which is shipped with the ASO software package, allows you to reserve a memory heap that is adequate for the needs of your application.

The reserved memory heap is part of the total physical memory available in your system. When your program requests memory, the memory buffer is allocated from the reserved memory heap instead of from the Windows global heap. The KMM is DAS product independent and can be used by multiple Keithley DAS Windows programs simultaneously. Also, the memory allocated with the KMM can be used by a DMA controller, if applicable.

The KMM includes the following files:

- **VDMAD.386** - Customized version of Microsoft's Virtual DMA Driver for Windows 3.1 or Windows for Workgroups 3.11. When you use the KMM to reserve a memory heap, Microsoft's Virtual DMA Driver is replaced by the VDMAD.386 file.
- **VDMAD.VXD** - Customized version of Microsoft's Virtual DMA Driver for Windows 95. When you use the KMM to reserve a memory heap, Microsoft's Virtual DMA Driver is replaced by the VDMAD.VXD file.

Note: If you have multiple versions of VDMAD.386 or VDMAD.VXD, you should install the latest version; to determine which version is the latest, refer to the time stamp of the file.

- **KMMSETUP.EXE** - Utility that helps you set up the KMM parameters and then modifies your Windows configuration files accordingly.

Installing and Setting Up the KMM in Windows 3.1 and Windows for Workgroups 3.11

To install and set up the KMM whenever you start up Windows 3.1 or Windows for Workgroups 3.11, you must modify the SYSTEM.INI file. You can modify the SYSTEM.INI file using either the KMMSETUP.EXE program or a text editor.

Using KMMSETUP.EXE

Use KMMSETUP.EXE to modify your Windows SYSTEM.INI file as follows:

1. Double-click the KMM icon in the DAS-1700 program group.

   The Keithley Memory Manager - Setup panel appears.

2. Specify the appropriate options. For more information, click **Help** on the panel.

3. Click **Update** to update the SYSTEM.INI file with the changes you have made.

4. If you changed the default value, click **Restart Windows** to ensure that the changes take effect immediately.

Using a Text Editor

Use a text editor to modify the [386Enh] section of your SYSTEM.INI file as follows:

1. Replace the line `device=*vdmad` with the following statement:

   ```
   device=c:\windows\vdmad.386
   ```

   Note: Normally, the VDMAD.386 file is stored in the WINDOWS directory; if it is stored elsewhere, enter the correct path and name.

2. Add the following line:

   ```
   KEIDMAHEAPSIZE=<size>
   ```

   where *size* indicates the desired size of the reserved memory heap in KB.

Notes: The memory size you specify is no longer available to Windows. For example, if your computer has 8 MB of memory installed and you specify `KEIDMAHEAPSIZE=1000` (1 MB), Windows can only see and use 7 MB.

If you do not add the `KEIDMAHEAPSIZE` keyword or if the size you specify is less than 128, a 128 KB minimum heap size is assumed. The maximum heap size is limited only by the physical memory installed in your system and by Windows itself.

3. Restart Windows to ensure that the system changes take effect.

Installing and Setting Up the KMM in Windows 95

To use KMMSETUP.EXE to modify your Windows 95 Registry and the SYSTEM.INI file, perform the following steps:

1. Point to **Programs**, **Keithley DAS-1700**, and **Memory Manager Setup** on the **Start** menu.

   The Keithley Memory Manager - Setup panel appears.

2. Specify the appropriate options. For more information, click **Help** on the panel.
3. Click **Update** to update the SYSTEM.INI file with the changes you have made.
4. If you changed the default value, click **Restart Windows** to ensure that the changes take effect immediately.

Removing the KMM

If necessary, you can remove the updated information from the Windows configuration files and return all previously reserved memory to Windows.

If you are using KMMSETUP.EXE, click **Remove** to remove the updated information. If you are using a text editor (for Windows 3.1 or Windows for Workgroups 3.11 only), modify and/or delete the appropriate lines in SYSTEM.INI. In either case, you must restart Windows to ensure that the changes take effect.

D

CE Information for the DAS-1700 Series

Note: Products that contain the CE mark are certified to meet European EMC directive 89/336 EEC. If this directive is not of importance to your application, please disregard the information in this document.

Keithley MetraByte certifies that this product has been tested and found to be in compliance with the EMC directive and relevant harmonized standards.

This document describes the limitation of certification, the declaration of conformity, and the cabling instructions required for the CE configuration.

Limitation of Certification

This certification applies only to the operation of the product (with specified cables and accessories) in the stated configuration and under the stated operational and environmental specifications. Any modification, misuse, or improper or inadequate maintenance of the product by the user voids this certification.

Any deviation from the specific configuration may cause emissions or susceptibility not within the allowed limits required by the stated directive. It is the user's responsibility to demonstrate and maintain compliance with the directive and standards.

Please read the next section, "Declaration of Conformity," for the specific testing configuration for this product. Consult the Keithley Instruments GMBH office (European importer) or Technical Support in Taunton, MA, USA, for further information regarding the exact configuration details and testing.

Declaration of Conformity

Application of Council Directive(s)	89/336/EEC
Standard(s) to which Conformity is Declared	EN50081-1, EN50082-1
Manufacturer's Name	Keithley MetraByte
Importer's Name	Keithley Instruments GMBH
Importer's Address	Landsberger Str.65 D-82110 Germering, Munich
Type of Equipment	Data Acquisition Plug-in Boards
Model Numbers	DAS-1701ST, DAS-1702ST, DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR, DAS-1702HR-DA, DAS-1701AO, or DAS-1702AO with EXP-1800, an ENCL Series enclosure, FWA-EXP, FWA-1800U, and SDAS-2000
Year of Manufacture	1996

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Place: Taunton, MA USA

(Signature)

Date: 01 August 1996

Mark Urban
(Name)

Quality Assurance Manager
(Position)

Cabling Instructions for the CE Configuration

When using an EXP-1800 as part of the CE configuration, you must use an ENCL Series enclosure. The ENCL-1 supports one EXP-1800, the ENCL-2 supports two EXP-1800s, and the ENCL-4 supports four EXP-1800s.

Each version of the ENCL Series enclosure contains slotted board guides and a rear panel that accommodates the rear connectors of each installed EXP-1800. To install an EXP-1800 in an ENCL Series enclosure, perform the following steps:

1. Remove the four standoffs from each EXP-1800 to be installed.
2. Insert the EXP-1800 into the slots of a pair of board guides.
3. Gently push the EXP-1800 toward the rear of the desktop enclosure until the front-panel screws meet the tapped holes on the board guides.
4. Fasten the front-panel screws to the board guides.

An ENCL-4 containing four EXP-1800s is shown in Figure D-1.

Figure D-1. ENCL-4 Enclosure with Four EXP-1800s Installed

Once the EXP-1800 is installed in the ENCL Series enclosure, connect the EXP-1800 directly to the main I/O connector of a DAS-1700 Series board through the SDAS-2000 cable, as shown in Figure D-2. Figure D-2 also shows where to attach the FWA-EXP and FWA-1800U. Refer to the *DAS-1700 Series User's Guide* and the *EXP-1800 User's Guide* for more information.

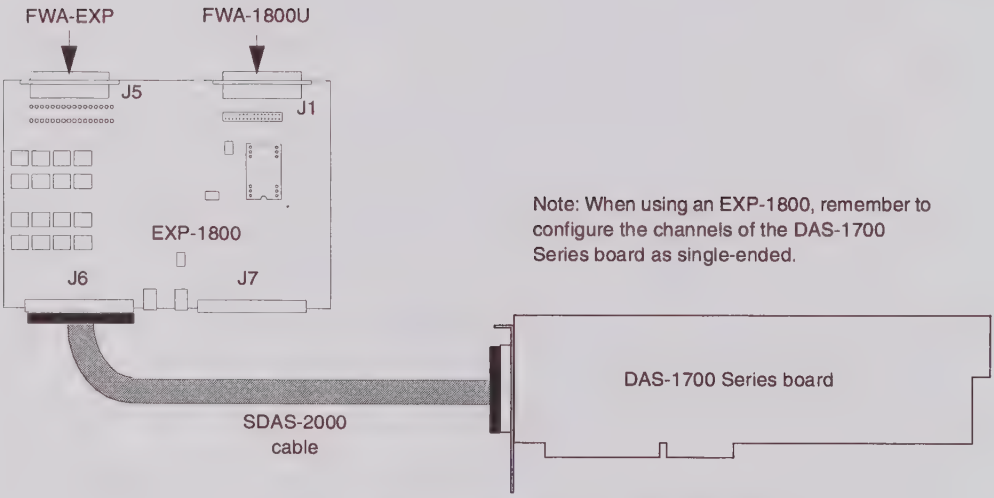


Figure D-2. Connecting the DAS-1700 Series Board to an EXP-1800, FWA-EXP, and FWA-1800U

Index

A

A/D FIFO 7-22
about trigger 7-17
about-trigger acquisition 7-20
accessories 1-5
  attaching 3-1
  EXP-1800 expansion accessory 1-5, 3-11
  MB01 backplane 1-5, 3-8
  MB02 expansion backplane 1-5, 3-8
  PG-408A DC/DC converter 1-6
  RMT-02 rack mount enclosure 1-5
  SSH-8 accessory 1-5, 3-7
  STA-1800U screw terminal accessory 1-5, 3-1
  STP-50 screw terminal panel 1-5, 3-6
ADC 7-6
analog input channels
  expansion 7-7
  gains and ranges 7-8
  input configuration 7-6
  selecting 7-9
analog input features 1-1, 1-3, 7-6
analog input ranges (gains) 7-9
analog output features 1-1, 1-3, 7-23
  DAS-1701AO 7-24
  DAS-1701ST-DA, DAS-1702ST-DA 7-23
  DAS-1702HR-DA 7-24
analog trigger 7-17, 7-26
analog-to-digital converter: *see* ADC
ASO-1700 software package 1-4
  installing 2-2
attaching accessories 3-1
automatic channel scanning 7-10

B

base address switch 2-9
base address, configuring 2-7, 2-9
bias return resistors 3-17
bipolar input range type 7-8
  configuring 2-7
block diagram
  DAS-1701AO, DAS-1702AO 7-5
  DAS-1701ST, DAS-1702ST, DAS-1702HR 7-2
  DAS-1701ST-DA, DAS-1702ST-DA 7-3
  DAS-1702HR-DA 7-4
board
  configuring 2-4
  installing 2-10
  unpacking 2-1
board type 1-1
  configuring 2-7
burst conversion mode 7-14
burst conversion mode with SSH 7-15
burst mode conversion clock
  analog input 7-16
  DAS-1701AO, DAS-1702AO 7-26

C

C16-MB1 cable 1-6
C-1800 cable 1-6
C-2600 cable 1-6
CAB-50 Series cable 1-6
cables
  C16-MB1 1-6
  C-1800 1-6
  C-2600 cable 1-6
  CAB-50 Series 1-6
  CACC-2000 1-6
  CDAS-2000 Series 1-6
  shielded 3-13

CACC-2000 cable 1-6
CAL1700.EXE 1-4, 6-5
calibrating a board 6-5
calibration equipment 6-2
calibration utility 1-4, 6-5
CDAS-2000 Series cable 1-6
CE Mark certification D-1
CFG1700.EXE 1-4, 2-5
channel-gain queue 7-10
channels, analog input
    expansion 7-7
    gains and ranges 7-8
    input configuration 7-6
    selecting 7-9
clock
    analog input 7-15
    DAS-1701AO, DAS-1702AO 7-25
common: *see* ground reference
common-mode voltage errors 3-17
computers supported 1-1
configuration options 2-4
configuration utility 1-4, 2-5
configuring a board 2-4
connecting accessories 3-1
connecting multiple boards 3-20
connecting signals 3-12
    analog output 3-18
    differential analog input 3-15
    digital I/O 3-19
    external digital trigger 3-19
    external pacer clock 3-19
    hardware gate 3-19
    single-ended analog input 3-14
    SSH output (SSHO) 3-19
    strobe (DOSTB) 3-19
    trigger/gate output (TGOUT) 3-19
connector J3 (STA-1800U) B-4
connectors J1 and J2 (STA-1800U) B-3
connectors J4 to J7 (STA-1800U) B-5
consecutive channels: *see* automatic channel scanning
control lines
    external gain 7-8
    multiplexer 7-8
control panel 1-4, 4-1
conversion modes, analog input 7-13
creating a configuration file 2-6
CTL1700.EXE 1-4, 4-1

D

D/A FIFO 7-27, 7-28, 7-29
DACs
    DAS-1701ST-DA, DAS-1702ST-DA 7-23
    DAS-1702AO 7-24
    DAS-1702HR-DA 7-24
daisy-chaining
    EXP-1800 expansion accessories 3-11
    MB02 expansion backplanes 3-10
DAS-1700 Series Calibration Utility: *see* calibration utility
DAS-1700 Series Configuration Utility: *see* configuration utility
DAS-1700 Series Control Panel: *see* control panel
DAS1700.CFG 2-5
data format 7-8
data transfer
    analog input 7-22
    DAS-1701AO, DAS-1702AO 7-28
default configuration 2-5
differential inputs 3-16, 7-6
    configuring 2-8
digital I/O features 1-1, 1-3, 7-29
digital input lines 7-29
digital output lines 7-29
digital trigger: *see* external digital trigger
digital-to-analog converter: *see* DACs
DMA channels 7-22, 7-28
    configuring 2-7

DMA resources
analog input 7-22
DAS-1701AO, DAS-1702AO 7-28

E

equipment, calibration 6-2
EXP-1800 expansion accessory 1-5
attaching 3-11
attaching multiple 3-11
attaching power 3-11
configuring 2-8
external digital trigger
analog input 7-18
connecting 3-19
DAS-1701AO, DAS-1702AO 7-27
external gain control line 7-8
external pacer clock
analog input 7-16
connecting 3-19
DAS-1701AO, DAS-1702AO 7-25

F

features 1-1, 1-3
filtering 3-13

G

gain, analog input 7-9
gate
analog input 7-20
connecting 3-19
DAS-1701AO, DAS-1702AO 7-27
ground loop problems 3-17
ground reference 3-12, 3-19
configuring 2-8

H

handling a board 2-1
hardware gate: *see* gate
hardware trigger: *see* external digital trigger

I

inspecting a board 2-1
installing a board 2-10
installing the software 2-2
internal A/D pacer clock
analog input 7-16
DAS-1701AO, DAS-1702AO 7-26
internal D/A pacer clock 7-25
internal trigger: *see* software trigger
interrupt level 7-22, 7-28, 7-33
configuring 2-7
interrupts 7-33
analog input 7-22
DAS-1701AO, DAS-1702AO 7-28

J

jumper pads (STA-1800U) B-5

K

Keithley Memory Manager 4-1, C-1
KMM C-1
KMMSETUP.EXE C-3

M

main I/O connector pin assignments 3-4, B-2
MB01 backplane 1-5
    attaching 3-8
MB02 expansion backplane 1-5
    attaching 3-8
    attaching multiple 3-10
memory manager 4-1, C-1
modifying a configuration file 2-6
multiple boards 3-20
multiplexer control lines 7-8

N

noise prevention 3-13

O

operating systems supported 1-1

P

paced conversion mode 7-14
pacer clock
    analog input 7-15
    DAS-1701AO, DAS-1702AO 7-25
PG-408A DC/DC converter 1-6
pin assignments
    main I/O connector 3-4, B-2
    STA-1800U connector J3 B-4
    STA-1800U connectors J1 and J2 3-5, B-3
    STA-1800U connectors J4 to J7 B-5
post-trigger acquisition 7-19
potentiometers 6-2
powering
    boards 7-34
    EXP-1800 expansion accessories 3-11
power-up settings 2-5
pre-trigger acquisition 7-20
problem isolation 5-1

R

range
    analog input 7-9
    DAS-1701AO, DAS-1702AO 7-24
    DAS-1701ST-DA, DAS-1702ST-DA 7-23
    DAS-1702HR-DA 7-24
recycle mode 7-28, 7-29
repairing equipment 5-5
resistors, bias return 3-17
resolution 7-6
retrigger mode 7-27
return: *see* ground reference
returning equipment 5-5
RMT-02 rack mount enclosure 1-5

S

screw terminals assignments, STP-50 3-6
setting the base address switch 2-9
shielded cables 3-13
signals, connecting: *see* connecting signals
single channel 7-10
single-ended inputs 7-6
    configuring 2-8
slot size required 2-10
software supported 1-4
software trigger
    analog input 7-17
    DAS-1701AO, DAS-1702AO 7-26

specifications, analog input
DAS-1700AO Series A-8
DAS-1700HR Series A-5
DAS-1700ST Series A-2
specifications, analog output
DAS-1700AO Series A-12
DAS-1701ST-DA, DAS-1702ST-DA A-11
DAS-1702HR-DA A-12
specifications, digital I/O A-14
specifications, power supply
DAS-1700AO Series A-15
DAS-1701ST, DAS-1702ST A-14
DAS-1701ST-DA, DAS-1702ST-DA A-15
DAS-1702HR A-14
DAS-1702HR-DA A-15
SSH output signal (SSHO) 7-32
connecting 3-19
SSH-8 accessory 1-5
attaching 3-7
configuring 2-8
STA-1800U screw terminal accessory 1-5
attaching 3-1
DAC output labels 3-5
jumper pads B-5
pin assignments 3-5, B-3, B-4, B-5
start trigger 7-17
storing data: *see* data transfer
STP-50 screw terminal panel 1-5
attaching 3-6
screw terminal assignments 3-6
strobe signal (DOSTB) 7-30
connecting 3-19
synchronizing multiple boards 3-20

T

technical support 5-5
test points 6-2
testing your board: *see* control panel
throughput 7-11
time base
internal A/D pacer clock 7-16
internal D/A pacer clock 7-25
transferring data: *see* data transfer
trigger
analog input 7-17
DAS-1701AO, DAS-1702AO 7-26
trigger/gate output signal (TGOUT) 7-30
connecting 3-19
troubleshooting 5-1

U

unipolar input range type 7-8
configuring 2-7
unpacking a board 2-1
utilities
calibration 1-4, 6-5
configuration 1-4, 2-5
control panel 1-4, 4-1

V

VDMAD.386 C-2
VDMAD.VXD C-2

W

warranty repairs 5-5
wiring signals: *see* connecting signals

KEITHLEY METRABYTE

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